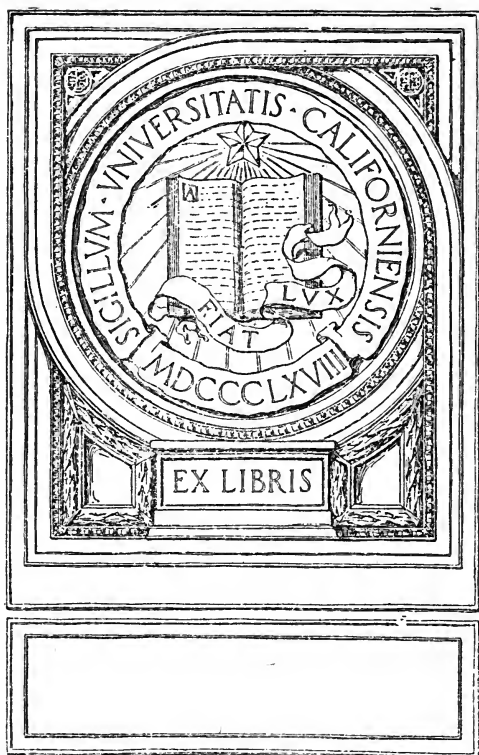


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A MANUAL OF FEVERS

OXFORD MEDICAL PUBLICATIONS

A MANUAL OF FEVERS

BY

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PREFACE TO THE SECOND EDITION

IN the preparation of this edition the whole book has been subjected to a thorough revision, and a considerable number of alterations and additions have been made. At the same time every care has been taken to keep the size of the volume within reasonable limits, and with this object in view I have resisted the temptation to add chapters on influenza, poliomyelitis, and encephalitis lethargica. These diseases, however, are only occasionally met with in the fever hospitals, and their omission from a volume primarily intended for students attending classes at those institutions may reasonably be excused.

CLAUDE B. KER.

EDINBURGH, *December* 1921.

PREFACE TO THE FIRST EDITION

THIS Manual is intended for the use of students who propose to take out the statutory course of "Fevers" at an Isolation Hospital. The possession of some degree of theoretical knowledge is very desirable if full advantage is to be derived from the clinical demonstrations given in the wards. A lecturer is often compelled to show examples of particular rashes or complications, not when they would best fit systematically into his course of instruction, but when they happen to be available, and this method of teaching, while not unsuitable for those who have done a moderate amount of preliminary reading, is most confusing to the student who knows nothing of the diseases shown. I have endeavoured in the following pages to give, in a compact form, the information likely to be required to supplement the practical work, and to treat the subject mainly from the clinical standpoint, in the hope that the book may not cease to be useful when its owner has entered upon general practice.

CLAUDE B. KER.

EDINBURGH, *July 4th*, 1911.

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MANUAL OF FEVERS

CHAPTER I.

INTRODUCTION.

Infection.
Immunity.
Fever.
Toxæmia.

The Stages of Fever.
Types of Pyrexia.
Management of Fevers.
Prophylaxis.

THE student who commences the practical study of the infectious diseases has presumably acquired some knowledge of bacteriology and pathology. It is not intended, therefore, in this introductory chapter to do more than mention briefly some of the more important facts connected with infection and fever and explain the technical terms which are likely to recur in this volume. The diseases to be treated of are due to living organisms. Several of these are known to be bacteria, some will possibly be found to be protozoa, many have yet to be discovered and may be ultra-microscopic.

Infection may be defined as the invasion of the tissues by a pathogenic micro-organism, that is to say a micro-organism which is capable of producing disease in man under natural conditions. The effect of its attack on the human subject will depend upon its virulence, which may vary greatly under different conditions, upon its dose, and upon the susceptibility

of the individual attacked. The latter will differ widely according to the age, race, and personal peculiarities of the infected subject.

Although it is often impossible to trace the connection, all infection must ultimately be derived either from a patient or a *carrier*. The latter is a person who harbours in some part of his body the causative micro-organism of a particular disease. He may have recently suffered from the disease himself without being able to get rid of the germs, in which case he is spoken of as a "convalescent" carrier. He may, on the other hand, have harboured the micro-organisms without contracting the disease although perfectly able to communicate it to others, and in this case he is termed a "healthy" carrier. This latter class is the more dangerous in that it is the least suspected.

From either a patient or a carrier, then, the infecting micro-organism is transmitted directly or indirectly. Direct or *contact infection* need not necessarily imply actual contact with the infecting agent, it being sufficient to come within the radius of his infectivity. In the act of talking, and still more in that of coughing or sneezing, every one expels microscopic droplets of fluid which may contain pathogenic organisms. A patient with measles, for instance, can disseminate infective droplets to the distance of nine feet. This variety of contact infection is often spoken of as *droplet or spray infection*.

Infection may also be transmitted indirectly. Articles which have been in contact with the patient, *fomites* (literally touchwood or tinder), may be dangerous. The clothes of the patient or of any one who has been visiting him may carry infection. Most important are such articles as have been in contact with his mouth or nose, for instance, handkerchiefs, pillow-slips, cups, spoons, and throat instruments, and, in

schools, towels, pencils, and penholders. The excretions of a patient or carrier may contaminate a water supply, and certain diseases are very liable to be disseminated by *water*. Infection, again, may be transmitted in *milk*, germs having been introduced by dairy-workers who may either be carriers or in attendance on the sick, or the milk cans may have been washed with infected water. Various *food substances*, such as vegetables and shell-fish, are also liable to contamination. In the production of certain diseases a very important part is played by *insects*, which may either actively transmit infection by biting first an infected and then a healthy person, as does the louse in the case of typhus fever, or passively carry infective micro-organisms on the legs from faecal matter to food stuffs, as does the housefly in the case of enteric fever or infantile diarrhoea. Lastly, infected *dust* may sometimes be responsible for the contamination of milk and other foods, and dust particles containing resistant micro-organisms may be conveyed some distance by air. The importance of aerial convection, however, is probably exaggerated.

Reviewing the whole subject, one is inclined to emphasize the predominant part played by contact infection in many diseases. But the contact must be relatively close. Nurses, who have to handle patients more freely than doctors, frequently take infectious diseases. Ward-maids whose duties are not directly concerned with the patients seldom contract infection. Students attending ward clinics enjoy a remarkable immunity. I do not recollect a dozen instances of infection in twenty-five years' teaching, and over 4000 students have attended the City Hospital during that time. I can well understand a student, who may perhaps have an important examination impending, being very anxious not to take an infectious disease, but

it is well that he should realize that the risk is infinitesimal.

Infection takes place in three ways: by *ingestion*, as is usually the case in enteric fever; by *inhalation*, which we may assume takes place in such diseases as measles and smallpox; and by *inoculation*, which is the ordinary mode of infection in the insect-borne diseases and in such a condition as erysipelas. Bacteria produce disease firstly by their multiplication in the body, which may be called "infection," and, secondly, by the production of toxins or poisons which may act either generally or locally, "intoxication." In certain instances the multiplication of the micro-organisms appears to take place in the blood stream, but more usually a local nidus for multiplication is obtained either at the spot first invaded or in some of the other organs of the body.

The latent or *incubation* period which follows infection and precedes intoxication is not very easy to explain. But we know that, whereas some bacteria, for instance the diphtheria bacillus, give off toxins, or poisons, into a fluid medium, in the case of others the poison is an "endo-toxin" and contained in the cell substance. It is probable, therefore, that a certain time is required for the development in the body of antibodies, which either acting as bacteriolytic ferments break up the bacteria and set free the toxin, or by interacting with the foreign protein in the bacterial substance produce a secondary poison to which the symptoms of the disease itself are due.

After this period of latency the patient manifests symptoms which are usually both local and general. The local symptoms depend upon the action of the micro-organisms themselves and of various ferments which are formed locally by their action on the tissues. This direct action of bacteria may of itself be sufficient

to kill the infected subject, as when, for instance, a child dies suffocated as the result of obstruction caused by a diphtheritic membrane. The principal symptoms of infectious diseases, however, are the result of *toxæmia*, that is the circulation in the blood stream of the poisons resulting from the bacterial invasion.

Immunity implies non-susceptibility to a given disease or to a given organism. It may be *natural*, that is to say it is impossible to infect certain species of animals with a particular micro-organism, and certain individuals, again, are apparently born immune to certain infectious diseases. Immunity, on the other hand, may be *acquired* by passing through an attack of an infectious disease, this usually being sufficient to protect the individual against subsequent infection by the same micro-organism. The protection so obtained, or that secured by injections of dead or attenuated organisms or by sublethal doses of their toxins, has been termed *active immunity*. It is to secure this that preventive inoculation and vaccination are performed. The serum of an animal so protected, if injected into another animal or into the human subject, confers *passive immunity*, which, as a rule, is very temporary in character, and also can be used curatively for a person already suffering from the disease in question. Such a serum is usually spoken of as an *anti-serum*. It may be either antitoxic or antibacterial, that is to say it may have the power of neutralizing toxins or of protecting against the living bacterium itself.

The protection and recovery of the human organism is the result of an extremely complex process in which both the leucocytes and the blood serum take part. The leucocytes are usually increased in numbers as the result of infection, and phagocytosis doubtless is an important feature of the body's resistance to bacterial attack. Certain substances develop in the

blood serum which act upon micro-organisms in such a way that they are readily ingested by the leucocytes. To these bodies the name of "opsonins" has been given, and their estimation in the blood gives some idea of the amount of protection acquired against a particular infection. The blood serum itself has an inhibitory action on the growth of micro-organisms, and the particular substance in the serum responsible for this action has been termed "alexine," also "complement," and is present in normal blood. Ehrlich holds that special atomic groups in the molecules of the body cells have particular affinities for nutritive food stuffs which enter into combination with them. On the other hand, bacterial products may also have special affinities for some of these atomic groups, and thus toxin may enter into combination with these groups, the so-called "side-chains" of the cell. This may result in the death of the whole cell, or only of the side-chain, which is thrown off, leaving the cell to produce a new one in its place. The process of repair may go beyond what is absolutely necessary, and extra side-chains, capable of combining with the toxic molecules, are set free. In this way a substance which can combine with and neutralize toxin, or "antitoxin," in other words, may find its way into the blood, and on this theory the cells would respond appropriately to the foreign bodies capable of entering into combination with their atomic groups, and thus render them innocuous. When gradually increasing doses of toxin are given to animals this reaction of the cells is capable of liberating large quantities of antitoxin, and probably something similar occurs in the course of an infectious disease.

Other substances elaborated by the body tissues which play some part in protection are bacteriolysins, agglutinins, hæmolysins, precipitins, and so forth.

Their relation to each other seems to be very imperfectly understood.

Closely allied to immunity, although at first sight it appears to be the exact opposite of it, is the phenomenon known as **anaphylaxis**. If injections of certain substances, such as toxins or foreign proteins, are repeated after a suitably long interval, they may be followed by toxic symptoms. A guinea-pig which has received an injection of normal horse serum may die with symptoms of shock if even a small amount is injected after an interval of twelve or more days. The condition may be defined as one of *abnormal sensitiveness to a foreign protein*. An antibody to the particular protein has been formed, and this antibody has been practically identified with precipitin. When the second dose is given the interaction of antigen and antibody produces fatal or alarming results in laboratory animals and also in a very small minority of human beings. From a clinical point of view, then, it is necessary to recollect that a dose of antitoxic serum, given to a person who has had horse serum injected previously for the same or some other disease, may conceivably cause sudden death, or at least be attended by unpleasant sequelæ (see p. 263).

Fever has been defined as "a response in metabolism to the invasion of micro-organisms and a toxic disturbance of the regulation of temperature." It is something more than a mere elevation of temperature, which it is convenient to speak of as *pyrexia*, or "hyperthermia." Fever can occur in persons who manifest no pyrexia, and conversely pyrexia is met with in certain nervous and hysterical conditions which do not present the other signs of true fever. Nevertheless, a disturbance in the regulation of temperature may be regarded as the cardinal sign of fever. In addition to this the destructive phase of the process of metabolism

is exaggerated, and as a result wasting is a very prominent feature of fever.

Besides pyrexia and increased tissue waste, *febrile symptoms* include acceleration of the pulse and respiration, usually but not always proportionate to the temperature elevation. The tongue becomes furred, the saliva diminished, the gastric digestion impaired, and the patient loses his appetite and suffers from thirst. Constipation is generally present. The urine is usually scanty and high coloured, the percentage of urea excreted is increased, and chlorides are much diminished in quantity. Slight degrees of albuminuria may be present. The skin is hot, and in most fevers dry. The derangement of the nervous system is evidenced by headache, insomnia, and delirium. Prominent among the subjective symptoms are feelings of chilliness, sensations of soreness or tenderness of the skin, and pains all over the body. Actual rigors may commence the process, but in some fevers they are only infrequently observed, the same remark applying to the convulsions which occasionally occur in children.

Many of the above symptoms are probably due more to the toxæmia than to the pyrexia. An elevated temperature, however, is of itself distressing to the patient, who often experiences considerable relief if it is artificially reduced. Again, if the temperature rises above a certain height, or if it is maintained at an unduly high level for several days, it is unquestionably dangerous. Such a condition may be defined as *hyperpyrexia*. It is unusual for a temperature of under 106° to be considered hyperpyretic unless it shows no remission or is unduly prolonged. It is probable, indeed, that within certain limits pyrexia is in itself a protective agent, and it is certainly the case that in many infectious conditions patients who show a good temperature reaction have a better

chance of recovery than those in whom the temperature is trivial or subacute.

While the majority of the symptoms met with in the different infectious diseases are certainly due to the *toxæmia* produced by the infective organisms, and so far may be described as *toxic*, it is customary to reserve this term for cases in which the patient is apparently overwhelmed by the poisons of the disease. Broadly speaking, then, a toxic case is a "malignant" case. Toxicity is often evidenced by the escape of blood or bloodstained serum into the skin tissues, with resulting purpuric eruptions or "stained" rashes. The toxins of particular diseases may have a special affinity for particular tissues, as for instance the peripheral nerves and heart muscle in diphtheria or the renal tissue in scarlet fever. Cases in which the central nervous system seems especially poisoned, as shown by delirium, insomnia, subsultus, and so forth, are often spoken of as "ataxic," while those in which the heart and circulation suffer most and prostration is very evident are termed "adynamic."

The Stages of Fever.—In describing the course of a fever it is usual to divide it into the following stages. First, there is the stage of *incubation*, lasting from the moment of infection until the moment of the first symptom, and during which the disease remains entirely latent. The length of this period varies much in different diseases, and also shows considerable variations in the same disease. It is followed by the stage of *invasion*, which may be regarded as lasting from the first symptom shown by the patient to the moment at which the temperature reaches the acme, or at which, if the fever is an eruptive one, the rash appears. During this stage the temperature mounts rapidly or slowly, and the onset is either abrupt or insidious. The next stage, that of *advance*,

or the "fastigium," lasts as long as the temperature is maintained, and in an eruptive fever usually coincides with the period of eruption. It may be as short as twenty-four hours or last for many weeks, as is some-

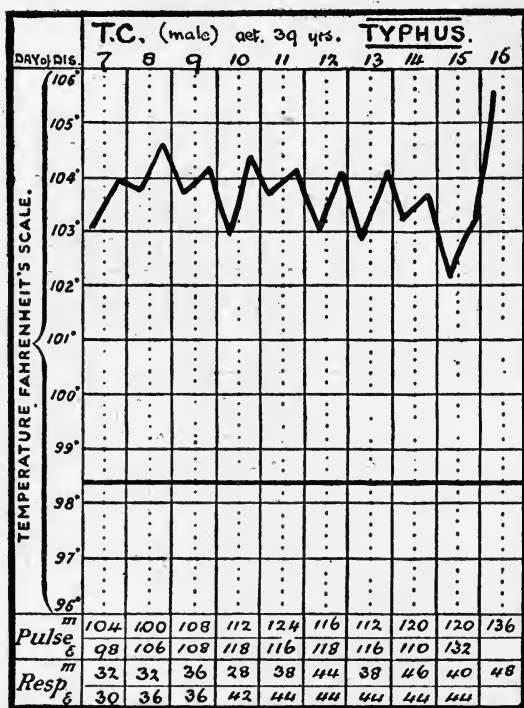


FIG. I.—Illustrating "continued" temperature with little or no remission. From a case of typhus fatal on 16th day.

times the case in enteric fever. With the first fall of temperature commences the stage of *defervescence*. This may occur rapidly by "crisis," the normal being attained in from twelve hours to two days, or slowly by "lysis," the pyrexia gradually subsiding, and relaxing its hold upon the patient, as it were, only by degrees.

The last stage is that of *convalescence*, during which the strength is regained, and the loss of weight, which has often been considerable, is made up.

Types of Pyrexia.—The student should familiarize himself with the different types presented by the charts of different febrile diseases. A temperature is said to be *continued* if it is maintained much at the same level with only slight diurnal variation. It is usual, however, for the morning readings to be about a degree lower than those registered at night.

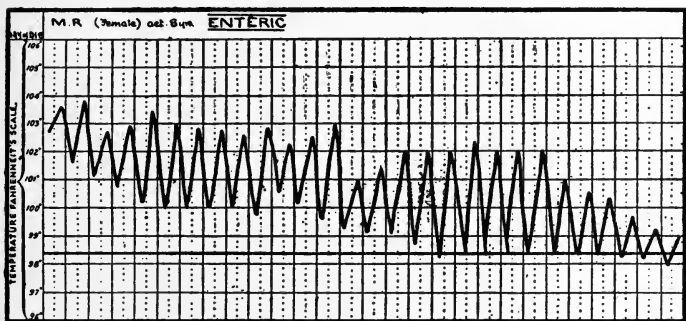


FIG. 2.—Illustrating “remittent” temperature. From a case of enteric fever.

The temperature of patients who are sharply ill, or who suffer from serious fevers, such as enteric, should be taken every four hours in order that any alteration in the usual level may be at once appreciated. Pyrexia is said to be *remittent* if the fall usually noticed in the morning hours exceeds a degree and a half, and *intermittent* if accesses of fever are separated from each other by intervals of normal temperature (see Charts 1, 2, 3).

Management of Fevers.—The special indications for particular diseases will be found in the appropriate sections of this volume. The first necessity is to

secure, if possible, a large airy room. The fever patient does not catch cold, and he should be given as much fresh air as possible. Open-air treatment is often of advantage, as it encourages appetite, helps to secure sleep, and stimulates the circulation. Hot, stuffy rooms do positive harm. The patient must of course be confined to bed as long as the temperature remains elevated. A good nurse should be provided, and among her

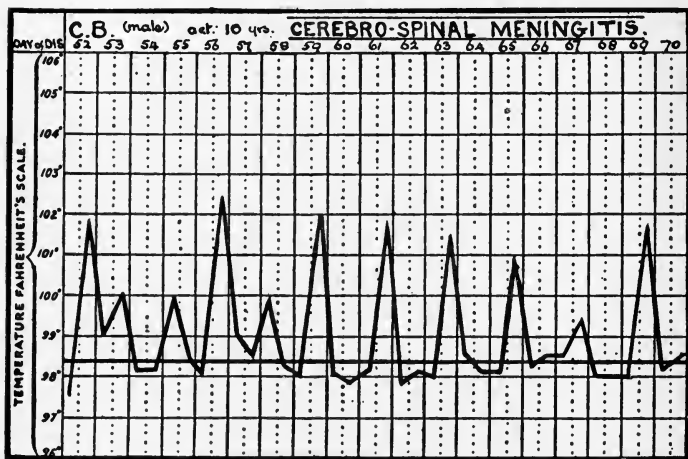


FIG. 3.—Illustrating “intermittent” temperature. From a case of cerebro-spinal meningitis in the chronic stage.

most important duties are careful attention to the condition of the skin, which should be frequently sponged, and the regular cleansing of the mouth. She should also see that sufficient fluids are administered, delirious patients often being too stupid to ask for a drink, and, for the same reason, that opportunities are given for micturition at not too long intervals. The back should be rubbed daily with a little methylated spirit, this being particularly necessary if the fever is likely to be prolonged.

As a general rule it is undesirable to attempt to reduce temperature, unless it shows a tendency to reach hyperpyretic levels. We have already seen that pyrexia may play some part in the processes of protection, and theoretically, therefore, it is reasonable not to interfere. The use of the coal-tar antipyretics, such as antipyrin and the like, is especially to be avoided. They will certainly reduce pyrexia, but seldom to the benefit of the patient, and in some cases may be actually dangerous. On the other hand, the use of tepid or cold sponges is often of great comfort to a feverish patient, and by reducing the pyrexia by one or two degrees may assist in producing sleep. Should there be hyperpyrexia, cold applications are, as a rule, to be preferred to drug treatment. Cold baths or the cold pack, which is more convenient, may be prescribed, and ice bags may be applied to the head, or the patient may be rubbed with blocks of ice. Sometimes good results are obtained by hot applications, which may lower temperature by encouraging sweating. This treatment is to be preferred when a rash is expected or is present at the time that the temperature becomes alarming.

The importance of giving a sufficient amount of cold water to drink cannot be overestimated. By promoting diuresis we encourage the free elimination of toxins, and such symptoms as headache, delirium, and subsultus are often favourably affected if the patient can be forced to drink freely. The bowels should also be carefully attended to, and the constipation so often observed in febrile conditions as far as possible prevented. Insomnia should always be regarded seriously, and treated actively from the first. It is well to remember in this connection that simple methods, such as the cool sponge or the administration of a hot drink, often work wonders, and

should always be tried before drugs are resorted to. When the latter are given, they should be pushed until sleep is obtained. A mixture of chloral and bromide, bromidia, paraldehyde, chloralamid, or veronal are remedies which are often effective. If the cause of the sleeplessness can be diagnosed, it should of course be dealt with. If, for instance, it is headache which is keeping the patient awake, a moderate dose of phenacetin or caffeine will often do all that is desired.

The *diet* suitable for each disease will be found in its appropriate place. It is wise to restrict the fever patient to fluids, unless the illness is likely to be very prolonged. The suggestions made for feeding enteric fever patients will be found useful in other forms of acute illness (see p. 214).

Specific Therapy.—In the case of certain of the infectious diseases it is possible to reinforce the resistance of the patient by the use of a vaccine or a serum. *Serums* are of two kinds, antitoxic or bactericidal. An antitoxic serum, such as that employed in the treatment of diphtheria, is used to neutralize the toxins of the infecting micro-organism and has no effect on the germs themselves. It confers, however, a passive immunity of a temporary nature and can therefore be used also for prophylactic purposes. An anti-bacterial serum destroys the micro-organisms by a process of bacteriolysis, and the anti-streptococcal and anti-meningococcal serums are of this type. A *vaccine* may be defined as a substance which, when injected into the animal body, induces the formation of specific antibodies. Perhaps the term "antigen" is a more suitable name for it. A culture of germs is either killed by heat or rendered avirulent by some other method and is injected in suitable doses either subcutaneously or intravenously. Too large a dose is apt to be followed by a reaction and a period of susceptibility

which has been termed "the negative phase." The dose should be graded to avoid this reaction, and should be gradually increased if a reaction has not occurred. The more severe the case the smaller should be the dose. An interval of two or three days between the doses is usually recommended. Vaccines may be ordinary *stock* cultures or *autogenous*, that is to say prepared from the patient's own micro-organisms. They can also be *sensitized*, that is exposed to the action of an immune serum. It may be broadly stated that vaccines have established a better reputation for prophylactic than for therapeutic purposes.

Prophylaxis.—In dealing with infectious cases our duties are not limited to looking after the individual. Our attention must also be directed to the protection of others. The first consideration is the *notification* of the case to the Medical Officer of Health. This is compulsory in the case of most of the diseases dealt with in this volume, but the lists adopted by different cities to some extent vary. In certain towns, for instance, measles is notifiable, in others it is not. Occasionally a disease which is not in ordinary circumstances notifiable, say for instance chickenpox or cerebro-spinal fever, is made so for a limited period for special reasons.

The next consideration is the *isolation* of the patient. In the case of the more serious infections, such as small-pox or typhus fever, this must be carried out in hospital. As regards less dangerous diseases, such as scarlatina or diphtheria, home isolation may be permitted if in the opinion of the Medical Officer of Health there is sufficient accommodation to carry it out satisfactorily. In such a disease as typhus *quarantine*, or the detention of contacts in a reception-house for the maximum incubation period, is very necessary, and whatever the infection, a period of quarantine must in any case be imposed upon susceptible children attending school,

The last measure we have to consider is *disinfection*. In regard to this it is important to recollect that a great deal can be done with soap and water and ordinary domestic cleaning, and that without cleanliness disinfection is not likely to be effective. Secondly, it should be remembered that infection depends more upon the human subject than upon fœmites, and that it is no use to disinfect a house and to leave one or more dangerous "carriers" undealt with. It is owing to this that the results of disinfection as applied to schoolrooms and institutions have often been found to be disappointing. With these reservations disinfection is not only useful but necessary. As regards rooms, the most effective measure is spraying thoroughly the ceiling, walls, and floor with *formalin* in the strength of four ounces to the gallon. A little glycerine is sometimes added to make it adhere to the surface to be disinfected. Formalin is both clean and reliable. It does not blacken metal, as does sulphur, and does not decolorize articles of clothing. For disinfecting small rooms and articles which cannot be subjected to steam, the evaporation of formalin tablets in an Alformant lamp is a handy method. For bed-clothes, bedding, garments, curtains, and the like disinfection by *steam* will be necessary. This is of course carried out in a steam disinfector, into the chamber of which steam is introduced at high pressure, the contained air being first driven out through an exhaust, and the jacket of the chamber being brought to a higher temperature than its interior to prevent condensation. The articles must be left in the disinfector for at least twenty minutes. It is impossible to use this method for furs, leather goods or books, and blankets are often somewhat damaged by the process.

CHAPTER II.

THE EXAMINATION OF RASHES AND THROATS.

Examination of an Eruption.
Distribution.
Character.
Colour.
Facies.
Constitutional Disturbance.

Rashes likely to be confused with
the Exanthemata.
Examination of the Throat.
Points to be observed.
Causes of Sore Throat.

BEFORE considering in detail the infectious diseases themselves it is well to have some knowledge of the general principles which should guide us in determining the nature of any particular eruption. It must be remembered in the first place that all rashes are not obvious. On the contrary, they may have to be looked for. The symptoms presented by a particular patient may be such as to suggest that it may be advisable to look for a rash; thus a child who suffers from such symptoms as headache, sore throat, and vomiting might very well, if systematically examined, show evidences of a scarlatinal eruption, although at first sight there might be little in his appearance to suggest it. On the other hand, the rash may be the most obvious feature in the case, and is often the direct cause of the medical attendant being summoned.

Examination of an Eruption.—Once the presence of any eruption is recognized it should be thoroughly examined, as want of care may lead to unfortunate mistakes. In the first place, its **distribution** should be

noted, that is to say we must determine if it is visible over the whole skin surface, or whether it avoids or favours certain localities, as for instance the face or the neighbourhood of the larger joints. We may have to decide whether the flexor or extensor surfaces of the limbs suffer most, whether the arrangement is symmetrical on the opposite sides of the body, whether the mucous membranes are also implicated, and so forth. To take an example, the rash of scarlet fever avoids the face, which is, on the other hand, always involved in a measles eruption. Or, again, the forearms, which in smallpox show a relatively profuse eruption, are very markedly spared by that of chicken-pox. To determine the distribution of a rash, the patient should be examined from head to foot, and in the case of children it is advantageous to strip them entirely, so as to obtain a general view. The various parts of the body of an adult should be examined in succession. This inspection of the whole skin surface not only enables us to appreciate the distribution of an eruption, but it allows us to see at once if its character varies in different situations—a point, as we shall see, of considerable diagnostic importance. Moreover, by examining the whole body, there is less chance of the remains of a fading rash being altogether missed. A scarlet fever rash, for example, fades from above downwards, and may be still quite diagnostic on the legs when it has entirely disappeared from the trunk. Again, in certain situations a rash will tend to remain brighter and more typical than in others. Thus parts which are kept especially warm, such as the inside of the thighs, or parts which are dependent, such as the back, may give us information which we would fail to find elsewhere.

Having determined the distribution, the next point

to engage our attention is the **character** of the eruption. From the clinical point of view the eruptions which we have to consider fall roughly into three main groups. In the first division may be classed rashes depending on congestive hyperæmia of certain areas of the skin, and which may be fairly described as erythematous. These include simple and multiform types of erythema, punctate and papular rashes, and, as a subclass, the urticarial forms of rash. A second division covers those eruptions the elements of which contain lymph or pus, and includes vesicular, pustular, and bullous types. In the third division are hæmorrhagic eruptions, which may either present petechial spots resembling the marks left by louse-bites, or true purpuric blotches of varying size, such as are liable to occur in the toxic forms of almost any of the infectious diseases. These hæmorrhagic spots, unlike the elements of erythematous rashes, cannot be obliterated on pressure with the finger or by the stretching of the skin.

Of the elements which compose any given eruption we have in the first group to distinguish the mere uniform erythematous flush from the "formed" rash. In some of the exanthemata, notably scarlatina, the fusion of the elements of the rash sometimes gives the appearance of a uniform redness, but careful examination will usually reveal the true characters of the rash in some situation in which such fusion has not occurred. But, as a general rule, the infectious diseases which present an eruption show very distinctly the elements of which it is composed. Thus the characteristic feature may be the *punctate spot*, a minute circular area of redness smaller than a pin's head, and usually not raised at all above the surrounding skin level. In punctiform rashes these

minute spots are set together very closely upon a slightly paler background. Or the skin lesion may be a *macule*, a coloured spot, often rounded, but if large tending to be irregular in shape, and not raised above the skin. The macule in many eruptions rapidly becomes a *papule*, a circular raised spot often somewhat conical in shape, and easily appreciated by a finger drawn lightly across the skin surface. It is these formative elements which give the distinctive character to any eruption, and by their grouping, by their distribution, and so forth, we make our diagnosis. The arrangement, moreover, of erythematous macules, or large uniform blotches of redness, is often distinctive. They may be uniformly scattered, they may be limited to certain situations, they may present *circinate* or *ringed patterns*, or they may develop characteristic *urticarial wheals* in their centre, and thus resemble nettlerash. In examining a doubtful case all such peculiarities should be noted.

In the second group the elements if they are small in size may be described as *miliary*. Such are the sweat rashes, very minute vesicles of clear fluid, often with no surrounding inflammation, sometimes on an inflamed base, and showing as red points. In scarlet fever, also, when the rash is very intense, a little yellowish fluid may form as a miliary point over the punctate spots. A larger collection of clear fluid is called a *vesicle*, and if very superficial may assume very diverse shapes, as in chickenpox, while if set deeper in the skin, as in smallpox, it tends to be conical with a circular base. A vesicle, by the gradual formation of pus, is apt to become a *pustule*, as is the case in smallpox. Other pustules contain pus from their first appearance, as is seen in acne and pustular forms of eczema. The shape and size of the pustules, as well as their situation, may throw light upon their nature.

Lastly, other elements containing fluid are the "blebs" and "bullæ," usually of comparatively large size and irregular shape, which form in such conditions as erysipelas and pemphigus.

In the hæmorrhagic group of eruptions blood has escaped from the capillaries into the skin, and appears either as the minute circular petechial spot, to be distinguished from the louse-bite by the absence of the white central scar, or as an irregularly shaped purple or maroon coloured blotch. It must also be remembered that it is possible for hæmorrhage to occur into any of the elements of the other forms of eruption mentioned above. Thus there may be escape of blood or blood-stained serum into the base of a papule or into the cavity of a vesicle. It is also the colouring matter of the blood which is responsible for the staining left on the skin after measles and certain cases of scarlet fever.

After determining the character of a rash, it is well to try and get information from its colour. This unfortunately can only come with practice, and the student is advised to note carefully the colours presented, for instance, by scarlet fever and measles. It is useless attempting to describe colour in words, but most observers will be able to appreciate the difference of tint in the two diseases mentioned. Many rashes due to causes other than the exanthemata present a distinctly bluish tinge, which is sometimes of real value in distinguishing them.

The above examination, then, informs us of the distribution, character, and colour of the eruption. Having completed it, we are able to say whether the distribution is general or only partial, and whether its elements are similar in all parts of the body. Some rashes are polymorphous or multiform, presenting a scarlatiniform appearance in one situation, and morbilliform, circinate,

or urticarial elements in another. This *polymorphism* is always a strong argument against a rash being one of the exanthemata, rubella being, however, a notable exception to this rule. But even as regards rubella, the presence of an urticarial wheal, or of a circinate arrangement, on any part of the skin surface in the case of a doubtful rash should be sufficient to exclude any idea of that disease. Another question well worth considering is the amount of irritation caused by the rash. Much *itching* in a doubtful case suggests that the eruption is due to serum, some article of diet, or other similar cause, always assuming the rash in question is an erythematous one.

The examination of the eruption may well conclude with **inspection of the face**. Does it, for instance, show the bleary eyes of measles, or the congested, drunken appearance of typhus, or the circumoral pallor of scarlet fever? Does the patient look ill? or does he, considering the profuseness and brilliance of his eruption, look unexpectedly well? In rashes due to drugs, food substances, or serum injections, the latter is usually the case. Is the face puffy? Some slight degree of œdema, especially about the eyelids, is often noticed in serum and food rashes. Too much reliance must not be placed upon facial diagnosis, but taken in conjunction with other indications it is of great value.

In all cases the history of the symptoms shown by the patient and his general condition at the moment of examination must be considered. Broadly speaking, the absence of **constitutional disturbance** points to the rash being an adventitious one, and not one of the exanthemata. As we shall see in the case of individual diseases, there are exceptions, but the absence of pyrexia is nevertheless a strong point in favour of the rash being due to food, drugs, or some similar cause.

On the other hand, a definite history of symptoms pointing to any particular disease, taken together with a rash suggestive of that disease, would go far to outweigh the fact that the temperature is normal. Catarrh followed by a morbilliform rash, or sore throat by a scarlatiniform one, may be suggested as examples.

We may now consider the **rashes likely to be confused with the exanthemata**. In the first place, it is always possible that the *prodromal rash* of one disease may be mistaken for the true eruption of another. Thus scarlatiniform prodromal rashes occur in measles, chickenpox and smallpox, and lead to many mistakes, the difficulty of their recognition being enhanced by the fact that the patient may suffer from marked constitutional disturbance. Secondly, the large group of *drug rashes* has to be remembered. Thirdly, the various types of *serum rashes* may resemble very closely certain of the exanthemata. Fourthly, *enema rashes*, due to absorption from the intestine, may cause difficulty, as do the rashes of a similar nature which occasionally follow a dose of salts or some other hydragogue cathartic. Fifthly, we have *food rashes*, such as those due to eating shell-fish or various articles of diet in regard to which an individual patient may possess an idiosyncrasy. Sixthly, *septic rashes*, such as sometimes follow burns or are noticed in septicæmic conditions, must not be forgotten. And lastly, various skin conditions, which cannot be specified in detail, such as multiform erythema from various causes, roseolar and pustular syphilides, herpes, acne, and pemphigus may be mistaken for one or other of the exanthemata.

The differential diagnosis of the different diseases will be mentioned elsewhere. It may not be out of place to say here, however, that scarlatiniform rashes

may occur in the prodromal stage of measles, chicken-pox and smallpox, and may be also due to serum, enemata, sepsis, and to the following drugs—belladonna, quinine, various resinous substances such as copaiba, and to the synthetic remedies, such as antipyrin, veronal, aspirin, and so forth. Chloral hydrate, morphia, and chrysarobin may also cause erythema of a somewhat scarlet character. Measles may be imitated by the rashes due to resinous drugs, by certain prodromal rashes of smallpox, by serum rashes, by erythema due to food substances, and by rashes of a septic nature such as, for instance, those of septic scarlet fever. Rubella, from the polymorphous character of its eruption and from the mildness of its constitutional disturbance, is very liable to be confused with serum, enema, and food rashes. Smallpox may have to be differentiated from iodide and bromide eruptions, and from such conditions as acne or a pustular syphilide. In making all these distinctions the distribution of the eruption, the character of the eruption, the uniformity of the eruption, and its association with symptoms characteristic of the disease suspected, considered together with the possibilities or probabilities of another cause, will be the chief points to engage our attention.

As regards hæmorrhagic rashes, care must be taken not to mistake louse-bites for a petechial eruption.

Examination of the Throat.—In the group of diseases with which we have to deal the examination of the throat is of great importance. In many instances sore throat may be complained of, but, as we have seen is the case with eruptions, not infrequently the condition has to be discovered by the medical attendant. And here it may not be out of place to observe that no sick child has been satisfactorily examined unless the throat has been inspected. To take the case of diphtheria in particular, it is not un-

usual for throat lesions to exist for days before their presence is suspected by the most careful mother, and the medical man who takes it for granted that there is nothing amiss with the throat is incurring an unjustifiable risk.

It is almost unnecessary to say that a complaint of sore throat, apparent discomfort in swallowing on the part of a young child, or the presence of enlarged glands, nasal discharge, or croupy symptoms directly call for inspection of the fauces. It is wiser, however, not to depend upon such signs, but to examine the throat in all sick children as a routine.

Having decided to look at the throat, it is always well to complete the general examination of a patient first, as many children become very resistive and intractable after the throat is examined. It is a good plan, to avoid frightening and hurting a child who is willing to open its mouth, to make the examination in three stages. First, without inserting the spatula at all, look into the widely opened mouth and inspect the palate and uvula and whatever other parts are visible. This can be done at leisure, without causing a struggle. Secondly, depress the tongue with the spatula, carefully avoiding the back of the tongue. The child often tolerates this, and allows a careful inspection of the greater part of the tonsils and pillars. Finally, slip the spatula farther back and depress the tongue thoroughly, and by causing the child to retch expose completely the posterior pharyngeal wall and the lateral recesses of the fauces. Even the tip of the epiglottis can sometimes be seen. It is obvious that this final stage of the examination must be made hurriedly, but the previous stages having, as a rule, allowed a fairly deliberate inspection, the attention will be entirely directed to those parts not previously visible.

The principal points to be observed are the following. It should first be noted if the patient opens his mouth easily or not. In cases of quinsy or mumps there is great difficulty in opening the mouth, and a corresponding difficulty in getting a good view of the throat. Next, on inspection, we must determine if the fauces are swollen and œdematous, if they are merely red and congested, or if they are pale. Another point of importance is the symmetry of the throat. In quinsy one tonsil may cross the middle line and the uvula be carried to one side. The palate also tends to bulge downwards and forwards on the affected side. Next, it must be noted if there is any visible patching, exudation, or ulceration. Should such exist, its situation should be determined. Is it on both tonsils or one only? Does it involve the uvula, the palate, the pillars of the fauces, or the posterior pharyngeal wall? Further, its colour and appearance should be studied. Is it milk-white, dirty grey, or yellowish in tint? Is the lesion continuous? or does it consist of scattered patches of exudation or discretely arranged follicles? Next, it must be decided whether it is due to the presence of pultaceous or purulent exudation, to false membrane, to superficial ulceration, or to the sloughing base of an extensive ulcer. These observations having been made, it may be necessary to see the effect of a cotton-wool swab on the lesion. If the lesion wipes off, it is either a thin film of pus, a soft pultaceous exudate, or a parasitic growth of the nature of thrush. If it does not wipe off, it may be either membrane, ulceration, or slough. It may now be noted if attempts to detach it cause bleeding. If so, and the lesion appears membranous, we have a presumption in favour of diphtheria. Finally, we may complete the examination by inspecting the tongue, the lips, and the buccal mucous membrane, situations more characteristic of

such conditions as thrush than of the lesions of the infectious diseases described here.

In coming to a conclusion the student will do well to recollect the **possible causes of sore throat**. If the fauces are merely hyperæmic or congested, it is true that scarlet fever or rubella may be the cause, but simple catarrhal sore throat, acute rheumatism, and influenza must not be forgotten. When there is much œdema and dark redness, the condition may be due to scarlet fever or erysipelas, or to septic infection. If the swelling is at first unilateral, it is probably a quinsy. Patched throats are seen in acute rheumatism and various forms of septic sore throat, and the exudation is sometimes very membranous looking. Scattered yellow points suggest follicular tonsillitis, but it is well to remember that diphtheria sometimes starts simultaneously in several tonsillar crypts, and presents at first a follicular appearance. Herpes also may show scattered grey or yellow points. Shallow ulcerations, usually yellowish in colour, are observed in septic sore throat, septic scarlatina, and in Vincent's angina; and the superficial necrosis of the first stage of the last-named condition sometimes closely simulates a diphtheritic membrane. Very superficial greyish excoriations may be due to syphilis, as may be the deep sloughing ulcers which may be seen on the tonsils, palate, and posterior pharyngeal wall. Tubercular ulceration must also be remembered.

Having noted the appearances of the throat, they must be considered in conjunction with the history of the patient and the other signs and symptoms which he may present. The presence or absence of laryngitis, nasal discharge, pyrexia, glandular enlargement, albuminuria, and skin eruptions may serve to throw light upon a doubtful case. Much information can sometimes be gained by the microscopic examination of a

direct smear preparation from the suspected lesion, which might for instance show the presence of the spirilla of Vincent or the polar-stained rods of diphtheria, and the results of a culture will go far to decide whether the latter disease is present.

CHAPTER III.

MEASLES.

Etiology.	Relapses and Second Attacks.
Incubation.	The Blood in Measles.
Stage of Invasion.	The Urine in Measles.
Stage of Advance and Eruption.	Morbid Anatomy.
Stage of Defervescence.	Diagnosis.
Stage of Convalescence.	Prognosis.
Summary.	Treatment.
Types of Measles.	Isolation.
Complications.	Prophylaxis.

Synonyms—Morbilli ; Rubeola.

Etiology.—The *bacteriology* of measles is very uncertain. It has been attributed to a short, slender bacillus, and also to a micrococcus ; but although much work has been done on the subject there is as yet no definite evidence in favour of either micro-organism. It is generally admitted that the infective agent lies in the catarrhal discharges from the nose and eyes, and it is reasonable to suppose that it also exists in the blood, recent attempts to communicate the disease by blood inoculation having proved successful.

The geographical distribution of measles appears to be general, that is to say it is found in all *climates* and no *race* is immune. As to *age*, it is unquestionably much more frequent in the young, but it would be a grave error to regard it merely as a children's disease. Its prevalence in this country is so great that few

escape exposure to its infection during the earlier years of life, and its infectivity is so high that but few of those exposed escape an attack. But the illness may nevertheless be contracted at any time of life, and when the infection is introduced into an entirely unprotected community it is usual for the whole population of all ages to be attacked. This was well illustrated in the historical epidemics in the Farøe and Fiji Islands. In this country more than half the patients are under five years of age. Infants take the disease readily.

In our large cities measles may be said to be endemic, but at certain *seasons* it assumes epidemic prevalence. Such outbreaks are most likely to occur in the winter and early spring, and it is not unusual for them to be noticed only every second year. Occasionally there are two epidemic waves in the year, the best marked in December, January and February, and a less considerable one in May and June. The latter may be influenced by the resumption of school attendance after the Easter holidays.

Dissemination.—Measles is in the vast majority of cases acquired by direct contact with a person suffering from the disease. As the virus is contained in the catarrhal discharges, and as the patient coughs and sneezes for three or four days before the appearance of the rash, there are ample opportunities for the infection to be disseminated before the condition is recognized. It has been found that the dangerous area around such a person extends to about 9 feet, so it is not difficult to see how measles spreads so rapidly in schools. The infectivity is probably proportionate to the amount of the catarrh; it certainly declines very much when the rash appears, a period at which the catarrh commences to subside, and by the time the rash has disappeared is probably extremely slight. The virus is very short-lived. While it can be carried on the clothes of a third person for a

short distance, fomites do not play the same important part in its distribution as is the case in other infectious diseases. In the greatest number of instances measles is contracted at school and imported to younger children at home, and it may be concluded that its spread will be best limited by an adequate control of school outbreaks.

Incubation.—After the poison has been taken into the system, most probably through the air passages, a considerable interval elapses before the appearance of symptoms. This latent stage may be said to last from eight to twelve days from the moment of infection to the appearance of the first symptom, or from thirteen to fifteen days to the first signs of the eruption. In practice it will be found that a quarantine period of sixteen days for an exposed person is quite sufficient, provided always that at the end of that time he shows no pyrexia, no catarrh, and no Koplik's spots. During the last days of the stage of incubation there is often a considerable increase in the number of leucocytes. This change, however, does not appear to be invariable.

Invasion or Prodromal Stage.—This period of measles is particularly interesting for two reasons. First, it is at this time that the patient is most infectious. Secondly, there is often the greatest difficulty in recognizing the condition. It is highly desirable that the patient be isolated at the earliest possible moment, and yet an absolutely certain diagnosis may be impossible. The length of the stage is, moreover, very variable, and is usually relatively long, on an average three or four days, but occasionally it is as short as two, and it may be prolonged to seven days. Its three main characteristics are catarrh, pyrexia, and an enanthem on the mucous membranes.

The *catarrh* affects the eyes, nasal passages, larynx, and bronchial tubes. There is also some looseness of

the bowels, occasionally severe enough to be termed diarrhœa. The eyes are suffused and watery, and there is usually photophobia. These symptoms are in some instances exaggerated, and the conjunctivitis may be purulent. Sneezing as a rule occurs early, and the patient shows all the signs of a sharp cold in the head. Hoarseness is common, and some patients develop a laryngitis so severe as to demand operative interference. It is not unusual for such cases to be regarded as laryngeal diphtheria and notified as such. Catarrh of the bronchi is always present, and the patient suffers from a harsh, irritable cough, which is often very suggestive.

More or less *fever* is almost invariably present, but the temperature curve is irregular and shows great variation in different cases. In the majority, however, it rises on the first day of illness to a fairly high level, not infrequently 102° or 103° F. Thereafter it shows a curious tendency to decline to the normal line, which it reaches sometimes on the second, sometimes not till the third or even fourth morning. This subsidence of the pyrexia, the so-called *remission* of measles, is worth remembering, as otherwise the practitioner who has quite properly isolated a suspected case on the strength of fever and catarrh may be thrown off his guard by a temperature reading which is sometimes even subnormal, and which may remain in the neighbourhood of the normal line for as long as a couple of days. In another type of onset the pyrexia is remittent in character, normal in the morning and rising at night to levels varying from 100° to 101° F. In yet a third, the rarest type of all, the temperature rises gradually from the moment of the first symptom to the moment of the appearance of the rash. In such a case the invasion stage is usually a short one. In the types in which the remission of the pyrexia is

most characteristic the temperature is often normal on the morning of the day on which the eruption first appears, and runs up sharply, usually to a comparatively high level, with its appearance (Chart 4).

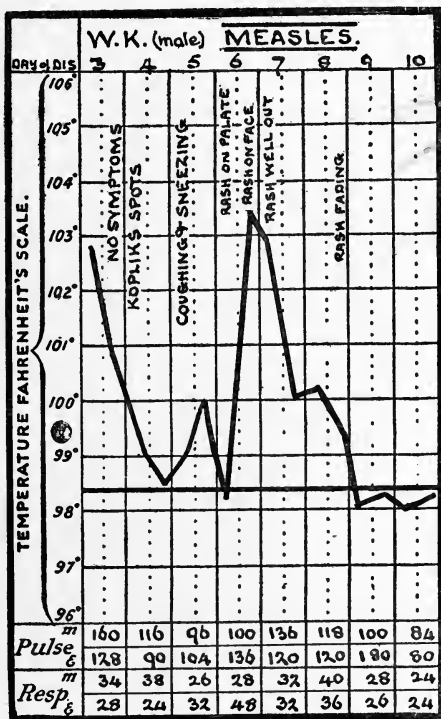


FIG. 4.—Measles. Showing the remission in invasion stage and the abrupt termination.

The *enanthem* on the mucous membranes of the mouth is of great importance. The mouth in measles is never what can be called "clean." The mucous membrane is congested and loses its glistening appearance, and yellowish pultaceous material often adheres

in places to the lining membrane of the cheeks and lips. The characteristic lesions, however, are the spots which were first described by Koplik. These are often to be recognized even on the first day of illness, and may be confidently expected on the second. They appear on the buccal mucous membrane, and are most likely to be seen first at the level of the first molar teeth. The individual spot consists of a minute bluish-white speck surrounded by a bright red areola. In size, speck and areola together do not exceed an ordinary pin's head, and may be much smaller. The spots are at first not very numerous, sometimes only two or three being visible, and in the first days of the prodromal period stand out well on the paler mucous membrane behind them. By the time the eruption is appearing, however, they may be present in great numbers, and from the blending of their areolas may present an appearance of tiny white specks on a deep red background. It should be noted that to see them bright daylight is required. They seldom show up well in artificial light. But, once recognized, the diagnosis of measles is definitely made. The typical Koplik's spot is not met with in other conditions. The spots may be seen on the inner surface of the lips as well as on the buccal mucous membrane, but they never occur on the palate. In the latter situation, however, a mottled rash is often seen some hours before the appearance of the eruption on the skin. The gums are liable to become swollen and even inflamed, and some observers attach considerable diagnostic importance to this condition, which is nevertheless not infrequently wanting. The tongue is usually heavily furred, but presents no special characteristics.

The amount of general disturbance occasioned by these symptoms varies much in different individuals. The patient usually feels ill and miserable, but is

seldom prostrated. Children quite frequently keep their feet until the rash appears, but they are apt to lose interest in their toys and do not run about. Such initial symptoms as vomiting, shivering, or severe headache are distinctly unusual. *Prodromal rashes*, as distinguished from the true eruption of the disease, are liable to occur, but are not very common. When present, they may be morbilliform, somewhat resembling the true eruption but badly developed, urticarial, or roughly scarlatiniform.

Stage of Advance and Eruption.—The eruption appears about the fourth day of illness, and with its development the *temperature* reaches its acme. A considerable degree of pyrexia is the rule, and the readings in most cases are 103° or over. The fever continues while the rash remains bright upon the patient, that is to say for about two days, only relaxing when it begins to fade. The pulse is accelerated in proportion to the amount of pyrexia, but the respirations are often relatively rapid. The patient suffers from the usual symptoms of fever. He may be troubled by insomnia, and is occasionally delirious. He is usually extremely uncomfortable and miserable, and is glad to keep his bed. The catarrh continues to some extent, but the cough and coryza not infrequently improve with the appearance of the rash. A peculiar musty odour is sometimes evident. After the first day of eruption it is quite impossible to distinguish Koplik's spots in the mouth.

The *eruption* is usually first visible at the roots of the hair and behind the ears, but it may appear first on the trunk. The face is soon invaded, and the circumoral region is equally involved. The eruption spreads rapidly downwards over the upper part of the trunk and arms, and within twenty-four hours of its appearance the patient is covered from head to foot.

The distribution, then, is general, the whole surface of the skin being involved. The characteristic skin lesion is a papule, more or less circular, dusky red to pink in colour, and, as it develops, appreciably raised above the skin. The papules are grouped together irregularly in such a way that comparatively large areas of skin are altogether free from the eruption and stand out as a dead white background to the rash. The grouped papules run together and coalesce into all sorts of irregularly shaped blotches or macules, many of which are roughly crescentic in outline. The raised character of the eruption enables the papules to be readily appreciated by the finger lightly drawn across the skin. They are soft to the touch, and are usually described as velvety. When fresh, they disappear readily on pressure or on stretching the skin, unless, indeed, there has been hæmorrhage into them. In such a case the eruption is almost purple, but does not necessarily denote a particularly severe attack, hæmorrhage of this sort having far less significance than is the case in the other eruptive fevers.

While, as a general rule, small white areas of unaffected skin may be seen here and there all over the body, the rash is sometimes extremely confluent. The back especially, in a well-marked case, may present an absolutely uniform redness, complete coalescence of all the eruptive elements having occurred.

The *facies* of the patient is highly characteristic. The discomfort which he suffers gives him a very woebegone appearance, which is heightened by his blotched face, puffy features, and bleary eyes.

The *staining* left by the eruption, at first brownish pink in colour, or dull purple if there has been hæmorrhage into the skin, gradually becomes yellowish

as it fades. In some cases it may even resemble the mottling left by the rash of typhus fever. It often remains visible for several days, and occasionally may persist for a week or even a fortnight.

Stage of Defervescence.—This is always rapid in uncomplicated cases. The termination of the fever is by *crisis*, the fall sometimes being complete in twelve hours, usually lasting twenty-four, and occasionally taking two days to attain the normal line. The rash fades as the temperature falls, disappearing from above downwards, as it came out, and leaving its characteristic staining behind it. Should the pyrexia persist after the rash has faded, complications must be looked for. The crisis is not accompanied by sweating. The patient's condition rapidly ameliorates with the relaxation of the temperature, and it is unusual for the catarrhal symptoms to persist unless some respiratory complication is present.

Stage of Convalescence.—At first the tendency is for the temperature to remain subnormal, and the pulse may be weak and irregular. But this depression rapidly passes off, and in two or three days the patient is usually fit to sit up in bed. The skin still shows the yellowish staining left by the rash, and a slight branny *desquamation*, which is in most cases completed within a fortnight, is often visible. During this stage many of the complications of measles are liable to make their appearance.

Summary.—It will be seen from the above that the duration of the fever in measles is for about seven or eight days. Of this the prodromal period takes three or four, the eruptive stage about two, and the period of defervescence one or two. After about four days of coryza and catarrh, during which the patient is most infectious, his rash appears with a rising temperature. The fever is maintained at a fairly high level while

the rash remains bright, and subsides by a slow crisis as the rash fades. Unless the case is a toxic one, *death* is not likely to occur during the true fever, except when complications are present from the first. The complication most likely to prove fatal at this early stage is obstructive laryngitis. Broncho-pneumonia seldom kills before the eruption has disappeared.

Types of Measles.—(1) *Mild Types*. Some cases are probably abortive. Thus an exposed child may have a fairly typical prodromal period, with characteristic mouth symptoms, and yet no rash may develop. Such a type might be fairly classed as *morbilli sine morbillis*. It is, however, very rare. On the other hand, the rash may be present, but throughout the course of the illness catarrhal symptoms are scarcely noticed (*morbilli sine catarrho*). Many cases of this latter type which have been described were quite possibly instances of rubella. The most ordinary of the mild types of the fever is one in which all the classical symptoms are present in a modified form. The pyrexia is slight, or may be entirely wanting, the catarrh trivial, the rash scanty and transient, and the respirations not accelerated. It must be remembered that true measles has been known to run its course with no elevation of temperature whatever.

(2) *Severe Types*. As in the case of the other infectious diseases, there is said to be a *hæmorrhagic* type, which, if it exists, must be extremely rare. It is not to be confused with those cases which show deep purple staining of the eruption, but is said to present purpuric spots and petechiæ, while bleeding is also liable to occur from the mucous membranes. It is described as being invariably fatal.

There is, however, a *toxic* type of measles which, though not frequently met with, is seen occasionally

in some epidemics. The patient succumbs to the virulence of the measles toxins quite apart from any complications. In most instances the fever is high, and is accompanied by delirium and marked prostration. The eruption, even if copious, tends to be badly developed, and loses its colour as the circulation fails. Death occurs on the second or third day of eruption, and the temperature reaches hyperpyretic levels towards the end. In young infants, even when the prodromal period has been uneventful, a great and sudden change for the worse is sometimes noted with the efflorescence of the rash. The pulse becomes extremely rapid and feeble, and the rash itself, though at first its colour may be good, if somewhat pale, never rises above the level of the skin, and is extremely evanescent. If it persists, it may become a pale violet in colour. Death in these cases is from heart failure, and is by no means invariably accompanied by hyperpyrexia. Sometimes, indeed, it is postponed till after the crisis, and the patient dies of collapse, with the temperature subnormal. Such cases may be termed "asthenic."

Complications.—These are of great importance, as, broadly speaking, they determine the death-rate, but few patients succumbing to uncomplicated measles. As would be naturally expected, in a disease which affects so markedly the **respiratory** tract, the most serious of the complications are to be found in that region. We have already seen that *laryngitis* is not an uncommon feature of the prodromal period. If, in addition to hoarseness and a croupiness of the cough, there is actual dyspnœa, the condition may be said to assume the importance of a complication. Sometimes the dyspnœa is sufficiently urgent to require operative interference. Usually it yields to the steam tent and local treatment. At this early stage it is probably due to a simple inflammation of the lining membranes

of the air passages, with a little superadded oedema, and perhaps some spasm at the glottis. It disappears in most instances with the appearance of the rash, though it occasionally persists through the eruptive stage. If the latter is the case, the condition sometimes depends on actual ulceration of the larynx, or on the formation of a false membrane, diphtheritic or otherwise, in the neighbourhood of the glottis. If laryngitis occurs in convalescence, it is nearly always, though not invariably, diphtheritic in nature. To sum up, it may be said that laryngitis before the rash is seldom, with the rash sometimes, and after the rash almost always, due to diphtheria.

Bronchitis is of less importance. It is seldom responsible for much more than a few days' moderate pyrexia, with slightly accelerated respiration and a persistence of cough. Coarse râles are heard all over the chest, as, indeed, is often the case from the first symptom of measles; for a certain amount of bronchial catarrh may be regarded as an ordinary concomitant of the disease. *Broncho-pneumonia* is the most important, as it is the most fatal, of all measles complications. It has been stated that more or less inflammatory change of this nature is to be found in every fatal case which comes to the post-mortem table, and this is probably correct. Broncho-pneumonia depends on a secondary infection by various cocci, the inflamed respiratory passages forming an excellent nidus for micro-organisms. The condition is almost certainly communicable from patient to patient in wards where cubic and floor space are limited. Like laryngitis, it may appear in the prodromal, eruptive, or convalescent stages of the disease. If it occurs early, it is often of the type we call acute capillary bronchitis, and is accompanied by noisy, wheezing breathing and acute suffocative symptoms. But if it appears with or after the development of the

rash, the bronchitic element is less marked, and the breathing, though occasionally a little harsh, can hardly be called noisy. Attention is usually first called to its presence by the rapidity of the respiration, which is often from 60 to 80 per minute in children of under five years of age. Crepitations are usually audible in various parts of the chest, though during the eruptive period there are often present coarse bronchitic râles which are apt to mask the finer sounds. Dulness may be detected here and there, though in the early stages of the inflammation this sign is very frequently wanting. Definite diagnosis is seldom possible till the rash fades, when the temperature, instead of falling sharply, only slightly relaxes, and the pulse and respirations remain extremely rapid. The face is pale, with a slight tinge of cyanosis. In cases with extensive lesions the lips may become purple. The nostrils expand on inspiration, and the breathing tends to become laboured. A short, irritable cough, often made worse by attempts at feeding, is sometimes but not invariably a marked feature. In severe cases the lower intercostal spaces recede on inspiration. The respirations are usually much more rapid than the rate of the pulse would lead one to expect, and the pyrexia often bears no particular relation to either. Some of the worst cases, in fact, have but little elevation of temperature from start to finish. As the disease develops, areas of dulness become recognizable by the blending together of small inflamed patches, and it is possible to hear crepitations and bronchial breathing in some of them. But the dulness may be due, on the other hand, to atelectasis, in which case there is little to be heard on auscultation.

The patient who presents these symptoms is very prostrated, and suffers not only from defective aeration of the blood and cardiac exhaustion, but also from the

toxæmia which is only naturally to be expected in an infective condition. The disease usually runs a prolonged course, not unlike typhoid fever, and it is only in very favourable circumstances that it terminates in ten days. As a rule it lasts for several weeks, and a large proportion of the patients die at about the end of the third week. Some, however, will survive even a six weeks' fever, during which the pulse has never been under 140 or the respirations under 60 per minute, while both may on many occasions have registered much higher figures. Death occurs in from one-third to one-half of the patients affected. The complication is most common in children of under two years of age, and is not seen very frequently when the age of five is passed.

It may be mentioned that *lobar pneumonia* occasionally, though rarely, is met with in older children and young adults. It may be followed by empyema. More important are *tubercular conditions of the lungs*, which are very liable to be induced by an attack of measles, especially if broncho-pneumonia has complicated the case.

Complications affecting the Eyes.—The eyes, like the respiratory organs, are more or less affected even in simple cases of measles, and are therefore equally prone to infection by micro-organisms. Inflammatory conditions are liable to occur, and almost any part of the eye may suffer. Sometimes there is blepharitis. More commonly, *conjunctivitis* accompanies or follows the attack. The inflammation is usually purulent, and there is great œdema and redness of the lids. This complication is often very obstinate, and may persist for a long time. It is particularly liable to be communicated to other children. Keratitis, with *ulcer of the cornea*, is not uncommon. In badly nourished children this ulceration is occasionally followed by perforation into the anterior chamber, and a destructive

panophthalmitis may result. More usually, opacities persist after the corneal ulceration has subsided, and these may permanently damage the patient's sight. Iritis is sometimes, but not very often, observed.

Otitis Media is as common in measles as it is in the other fevers. It is often accompanied by considerable pain, and is usually followed by perforation of the tympanum and the establishment of a purulent discharge. In bad cases mastoid disease may declare itself, but hardly so frequently as after scarlet fever. More rarely still, meningitis and cerebral abscess may be the ultimate results of the otitis. An attack of measles is only too often the cause of deaf-mutism, the comparatively large number of infants who take the disease no doubt accounting for this.

Adenitis is another not infrequent complication. The cervical glands are markedly enlarged, and occasionally suppurate. It is usually in convalescence that this condition declares itself, though some slight swelling of the glands may be noticed in a few patients even in the prodromal stage. The adenitis of convalescence is in most instances accompanied by some irregular pyrexia, often of a remittent type.

Enteritis is an important complication, but fortunately seldom occurs except in debilitated children. It is rarely seen until the rash has disappeared for some days. The motions may be extremely frequent, and the stools consist chiefly of mucus and blood, and may contain sloughs and shreds of membranous material. There is some abdominal pain, and frequently tenesmus. The condition may last for some weeks; it is highly resistant to treatment, and may be fatal. Pathologically it is probably a colitis, and appears to depend on some bacterial infection. It is apt to occur in small outbreaks, but is occasionally met with sporadically.

The simple diarrhœa so commonly met with in the prodromal and eruptive stages of measles is seldom serious.

Nervous Sequelæ.—It is usual to describe a large number of serious nervous diseases as being directly or indirectly the result of an attack of measles. For instance, hemiplegia, myelitis, chorea, tetany, and neuritis, to name a few of the most important, have been attributed to this cause. In a series of 12,000 consecutive cases the only sequela of this kind, noted as occurring in hospital, was a case of transverse myelitis, and it seems improbable that the toxins of measles have any direct effect on the nervous system.

Other Complications.—Stomatitis, often of an ulcerative character, may give considerable trouble in certain cases, particularly in those complicated with broncho-pneumonia. Occasionally *cancrum oris* results, a condition which is more frequently met with in measles than in the other acute infections. Vulvitis is also a possible complication, and may be followed by noma. Nephritis is extremely rare, and the arthritis and heart inflammations which are seen so comparatively often in scarlet fever are most uncommon. *Pregnancy* is very apt to be terminated by abortion.

Measles may be found in association with many of the other infectious diseases, particularly with diphtheria and whooping-cough.

Relapses and Second Attacks.—Relapse of measles is almost unknown, but does occur in rare instances. Second attacks are probably very rare also, though the popular impression is to the contrary. It is probable, when a person says he has had measles two or three times, that rubella accounts for one attack, and quite possible that another may be due to some form of erythema.

The Blood in Measles.—During the last few days

of the period of incubation there is said to be a well-marked leucocytosis. The increase in the number of white cells, when it exists, is due to a relative and absolute increase of the polynuclears. During the invasion stage the count appears to be somewhat variable, but many cases show the leucopenia which is said to be characteristic of the eruptive period. Unfortunately, these changes in the leucocytes cannot be counted upon with any great degree of certainty, and are liable to be influenced by the most trivial complications. Still, a count of 10,000 whites or under with an increased proportion of polynuclears should favour a diagnosis of measles if a suggestive eruption is present.

The Urine in Measles.—If there is high fever, some slight albuminuria may be present in the eruptive stage. Nephritis, as we have noted, is very rare. The urine, however, almost invariably gives the diazo reaction of Ehrlich. This is to be looked for towards the end of the eruptive stage, and may be confidently expected when the rash begins to show signs of fading.

Morbid Anatomy.—It cannot be said that measles presents any characteristic post-mortem appearances. Congestion of the lungs and mucous membrane of the respiratory tract, with occasional small hæmorrhages, is noted in patients who die in the eruptive stage. More or less broncho-pneumonia is to be expected. Ulcerations of the larynx are sometimes found. The Peyer's patches in the intestine are not infrequently prominent.

Diagnosis.—The disease is not likely to be diagnosed in the prodromal period unless its presence is suspected. The wisest plan is to isolate an exposed patient at the first sneeze, the first rise of temperature, or the first Koplik's spot. The latter will give the only certain indication. The tendency of the

temperature to undergo remission should never be forgotten, as it is a serious mistake to assume all risk is over when the readings become normal. Other difficulties to beware of are the comparative frequency of laryngitis, sometimes obstructive, in this stage, and the possible presence of scarlatiniform or urticarial rashes. As regards the former, laryngeal diphtheria may have to be thought of, but if there is no visible patching in the fauces, if coryza is present, and if measles is epidemic, we are justified in assuming the patient is suffering from the less serious complaint. Cultures from the throat should, however, be taken as an additional precaution, and if the dyspnœa is urgent antitoxin should be given in case the result should be positive. The absence of such symptoms, as vomiting and sore throat and the presence of coryza, should serve to distinguish a prodromal rash from scarlatina. In all cases Koplik's spots should be looked for, and their definite presence regarded as final. Their absence, on the other hand, is by no means conclusive.

In the eruptive stage the rash is usually characteristic enough to make the diagnosis certain. Marked involvement of the face should exclude *scarlatina*, which may be suspected if the rash is confluent on the body, and the presence of definite white areas of normal skin is always in favour of measles in drawing this distinction. The history of the initial symptoms of the patient will throw much light upon a doubtful case. If the rash is faded on the upper part of the body, the legs, which may be reasonably expected to show it in a fresher and more typical state, should always be examined.

It is often difficult to differentiate measles from rubella. In the latter disease, however, the prodromal catarrh is less well marked, the mucous membranes of

the mouth are normal, and the rash is more likely to be polymorphous in character, presenting different appearances in different parts of the body. The glands are also more generally enlarged than is the case in that mild type of measles with which rubella is likely to be confused (see p. 61).

The measles rash may have to be distinguished from the morbilliform prodromal rashes occasionally met with in *smallpox*, and also from the papular stage of the true eruption of that disease. Here, again, weight must be thrown upon the history of initial symptoms, possibilities of exposure to infection, and the presence or absence of coryza. The prodromal rash of smallpox, though measly in appearance, is not raised above the skin. As regards the true eruption, while the isolated papules are sometimes extremely like those of measles, they do not tend to coalesce into irregular blotches, and they are, as a rule, much harder to the feel, if not actually "shotty." As they come out, moreover, the temperature tends to fall, whereas in measles the opposite is the case. An examination of the mouth, if the case is one of smallpox, will often reveal definite vesicles on the palate, and the absence of Koplik's spots, so often still visible on the first day of a measles rash, would also be suggestive of the graver condition.

It may be sometimes necessary to remember that measles has been confused with *typhus fever*. The complete sparing of the face by the rash of the latter disease is the most obvious distinction, and the absence of catarrhal symptoms would also assist the diagnosis.

It is necessary to briefly mention other *rashes* liable to be mistaken for measles. Syphilitic roseola, especially when accompanied by fever, the rashes seen in infants during dentition, and those caused by the eating of various articles of food, such as shell-fish, must be

remembered. A morbilliform serum rash may resemble measles very closely. Drug rashes have also to be considered, perhaps the most important being that caused by copaiba and similar balsams, which sometimes assumes this form. The blotchy, angry red rashes due to septic infection, and seen so frequently in septic scarlatina, are occasionally liable to cause confusion. In distinguishing all the above-named conditions stress must be laid on the patient's history, the circumstances of the case, and the presence or absence of constitutional symptoms, such as fever for instance. Most of the rashes named, moreover, are likely to be less uniform than that of measles, and their distribution may be irregular. Septic rashes, for example, are best marked at the joints, serum rashes often show patches of urticaria, and so forth.

As regards the **diagnosis of complications**, little need be said. During the eruptive stage it is very difficult to make certain of the exact nature of a respiratory complication. It is generally safer to postpone the diagnosis of a broncho-pneumonia till the eruption commences to fade. If the pyrexia still persists and the respirations and pulse remain accelerated there is *prima facie* evidence that the complication is present. It may be some days before the coalescence of areas of inflammation give definite patches of dulness on percussion. Rises of temperature in the convalescence of measles may, if the respirations remain relatively infrequent, be expected to be due to adenitis or a developing otitis. Sometimes in the latter condition pain is not complained of.

Prognosis.—In considering this it is well to remember that measles is not a trivial disease. Under favourable circumstances and in good class practice it is quite true that the death-rate is very inconsiderable, but the infection is responsible for a very high

mortality among the children of the poor. And further, measles may leave all sorts of disablements behind it—opacities of the cornea and impaired vision, permanent deafness or deaf-mutism, and various lung conditions, such as emphysema or tubercular disease. Prognosis, therefore, should be always guarded, especially in hospital patients and in poor class practice. In Edinburgh, for the years during which compulsory notification was in force, the case mortality was 3·25 per cent., while the hospital death-rate was even higher, being no less than 6·75 per cent. It will be noted this is practically double the mortality of hospital-treated scarlatina.

Prognosis is most of all influenced by the *age* of the patient. During the first half-year of life the mortality is not quite so great as in the succeeding six months, and the death-rate reaches its maximum in the second year. Thereafter it progressively falls, and after the fifth year is passed becomes relatively trifling. The death of a patient of over ten years is in this country comparatively rare, and adults usually make a good recovery, their relative freedom from complications being much in their favour. Pre-existing disease, such as tubercle or syphilis, lessens the chances of recovery. During the *eruptive period*, provided the rash remains bright upon the patient, high levels of temperature, such as 105° or 106° , need cause no great anxiety; but should the eruption lose its colour and the high pyrexia still persist, the outlook is grave. Such a fading of the rash often implies a failing circulation, and should always cause alarm. Severe head symptoms and a small, rapid pulse are bad signs.

We have seen that the *complications* of measles are chiefly responsible for its mortality. Their presence, then, will influence the prognosis unfavourably

Laryngitis in the prodromal stage, if severe enough to cause any dyspnœa, must be regarded seriously, but there is always a good hope it will subside when the eruption appears. If dyspnœa persists into the eruptive stage it often proves fatal, and too much cannot be expected from operative interference in such cases, as the results of both tracheotomy and intubation are generally admitted to be disappointing. The mortality of cases of *broncho-pneumonia* varies from 20 to 80 per cent., according to the age of the patient, children under two years having a very poor chance of recovery. Its dangers correspond roughly with the pulse and respiration rates. If both remain very frequent, with no remissions, the outlook is worse than when some rest is given to the patient by a day or two's more moderate breathing. The temperature is of less importance, and is, indeed, in some of the very worst cases subacute. A very pale complexion, purple lips, and recession of the lower intercostal spaces are signs of evil omen.

The association of *diphtheria* with measles is always serious. The disease tends to be laryngeal, and we have seen that measles cases do not give good results with tracheotomy. Should, however, the diphtheria supervene in convalescence, there is always good hope for the patient if serum treatment is promptly resorted to.

Treatment.—Rest in bed from the moment the presence of the disease is suspected is essential. Much harm may be done by undue exposure of the patient during the prodromal stage. The room should be large and well ventilated, and may be with advantage darkened if there is much photophobia. The *diet* should be light. During the febrile stage it may well be restricted to milk alone, especially in the case of children. Adults, provided there is no

diarrhœa, may be allowed in addition beef tea, chicken jelly, or egg flip. Water should be freely supplied. When the temperature has fallen, milk puddings and other soft solids may be given, to be followed shortly by white fish. It is well to be strict in the feeding of children, as we must keep the possibility of enteritis before us. It is often much easier to start severe diarrhœa than to stop it. Adults after a week's normal temperature may be allowed full diet.

Keeping the various complications of the illness in mind, we must do all we can to protect the chest, especially in those children who have a tendency to bronchitis. A light cotton-wool jacket and regular rubbing with stimulating oils may be employed with advantage. While very free ventilation is desirable, particularly in hospital wards, draughts playing directly on the patient must be avoided. An important feature of treatment is the *toilet of the eyes*, which should be cleansed with boracic lotion night and morning. In hospital, sponges must not be used for this purpose, clean cotton-wool swabs, which can be destroyed after use, being obviously safer. Should conjunctivitis be feared, a weak solution of silver nitrate, 5 grains to the ounce, may be used occasionally as a prophylactic. This measure is particularly useful in outbreaks of ophthalmia in a hospital ward.

The patient should be kept in bed for about a week after all fever has subsided.

It may be necessary to *treat symptoms*. The irritating cough is usually relieved by any simple cough mixture containing compound tincture of camphor. It is unnecessary to interfere with the temperature unless it exceeds 106° , but the frequent use of tepid sponges helps to keep a patient with considerable pyrexia fairly comfortable, and

often induces sleep. Severe headache and mental excitement may be relieved by the application of ice to the head. Hypnotics are seldom required in so short a fever; in children bromide of sodium is often efficacious. Should the eruption be scanty or of a bad colour, hot mustard fomentations, or packing in blankets and hot bottles, will be found of service.

As to the *treatment of complications*, laryngitis often improves rapidly in a steam tent. Should there be any suspicion of diphtheria, serum must be given at once. Surgical interference for dyspnoea in the prodromal stage should be postponed to the last moment in hope of improvement accompanying the efflorescence of the rash. As regards broncho-pneumonia, the suffocative bronchitic form sometimes met with during the eruptive stage often improves with hot poulticing and with the steam tent. The more ordinary form, on the other hand, should be given as much fresh air as possible, and treatment by steam should be avoided. The patient is most likely to recover if he is allowed to lie as long as possible in the open air and to sleep near an open window. The fresh air encourages sleep and appetite, and does much to conserve the strength of the patient. Open-air treatment has the additional advantage of acting as a prophylactic against tubercular sequelæ. The chest must be well wrapped up and the patient kept warm. The diet should be chiefly fluid, and the various proprietary foods are often of value. Egg flip, white wine whey, and wine jellies may also be useful. Free stimulation is often desirable, and such drugs as strychnine or strophanthus may be employed if the case is prolonged. Poultices should be avoided. Cold affusions to the chest often stimulate a failing respiration, and may help the return of air to collapsed areas. In very cyanosed patients leeches may be applied with advantage.

For *conjunctivitis* frequent eye-baths of boracic acid solution, and occasional washes with weak sulphate of zinc lotion (4 grains to the ounce), should be given, while for the more severe cases argyrol (5-10 per cent.) can be applied two or three times daily with great advantage. The ointment of the yellow oxide of mercury is also valuable, particularly when corneal ulceration is present. It is wise to keep the pupil moderately dilated by means of atropine. In eye conditions the general health of the patient should be looked to, and appropriate doses of Easton's or Fellowes' syrup can be given as a tonic. Otorrhœa and adenitis can be treated as in scarlet fever (see p. 103). *Enteritis* is often difficult to hold in check. Irrigations of the large intestine and small doses of calomel or grey powder will give the best results. The diet should be limited to milk, with lime water, and with perhaps the addition of raw meat juice or some suitable meat extract. Albumin water may also be useful.

Isolation.—A fortnight is ample, if not excessive, time so far as infection is concerned. Many hospital patients, even after a simple attack, are not physically fit for discharge till a week later.

Prophylaxis.—This question presents great difficulties, as infection usually occurs before the diagnosis is made. Compulsory *notification* is only practised by a few local authorities, the results obtained hardly justifying the expense. It is hoped that a system of school notification, which should not be difficult under the present arrangements for medical inspection of schools, will do something to limit the spread of the infection. It is in the schools that measles is apt to become epidemic, and it is upon its management there that the checking of epidemics must depend. *Closure of schools* has not, on the whole, however, proved a

success. When measles has occurred in a house all children attending infant schools should be kept at home. Older children who have had the disease can safely attend. Those who have not had measles should be excluded for more than a fortnight, the London County Council excluding them till the Monday following the expiration of fourteen days. It has been customary to carry out *disinfection* in schools, but, as in the home, thorough domestic cleaning is probably all that is required, the measles virus being very short-lived. As regards *isolation* in hospital, it can hardly be justified as a means of checking infection, as the mischief is usually done before the patient's admission, but it is undoubtedly the means of saving a large number of lives.

Attempts to immunize children by the injection of the blood serum of convalescents have been recently made in America with encouraging results.

A child should never be deliberately and wilfully exposed to measles infection. It may be very convenient, but the risk is too great, particularly to children under five years of age. Even under the best conditions, moreover, a comparatively simple attack may leave blindness, deafness, or pulmonary disease behind it. Isolation should therefore be always attempted, even if the chances are against it being effective.

CHAPTER IV.

RUBELLA.

Nomenclature.	Types.
Etiology.	Prognosis.
Stage of Incubation.	Diagnosis.
Stage of Invasion.	Treatment.
Stage of Eruption.	Isolation.
Stage of Convalescence and Des-	Prophylaxis.
quamation.	The Fourth Disease.

Synonyms—German Measles ; Rötheln ; Epidemic Roseola ; Epidemic Rose Rash.

Nomenclature.—As will be seen from the above list of synonyms, this particular infection has many names. The most convenient, and that which seems most likely to be generally adopted, is “rubella.” Some have used the term “rubeola,”—the French name for the disease is *rubéole*,—but this term is also used, though quite incorrectly, to designate measles, which should be always termed “morbilli.” It would seem best to forget that we took our first correct description of the disease from Germany and to drop all designations except that of “rubella.”

Etiology.—Rubella is doubtless caused by a micro-organism, but as yet it has not been identified. We can put aside all the old theories, which suggested that the disease was a hybrid between measles and scarlet fever, or that it was one of these two infections in a highly modified form. Such views cannot for a

moment be entertained to-day. Rubella breeds true, that is to say it reproduces itself and causes neither scarlatina nor measles in those infected by it. Nor does an attack of it protect against either of these diseases. Again, to have had measles or scarlatina previously is no protection against rubella.

The disease is hardly so common as either measles or scarlatina, and unlike them is not apt to remain endemic in large cities. It occurs in epidemic waves at considerable intervals. Its most typical *season* is the spring and early summer. The *age* incidence is almost certainly higher than that of measles, and the proportion of cases occurring in the first five years of life is much less. Adults contract the infection readily, and, so far as hospital figures go, rubella is more common after twelve years of age than before it. This fact, however, probably depends upon the fallacy that the numerous children who contract the infection are seldom sent into hospital. Males and females are affected in equal numbers.

Rubella is highly infectious to those brought into close contact with it, but hardly so infectious as is measles. The *infection* probably lies in the catarrhal discharges from the nose and throat. It is extremely short-lived, and it is doubtful if it can be carried by a third person. Fomites do not appear to play much part in its dissemination. As in measles, the prodromal stage and the early eruptive stage are the most infectious.

Incubation Period.—This is longer than the corresponding periods in measles and scarlatina. In many cases it is about eighteen days from exposure to the appearance of the rash. From exposure to the first symptom the limits may be placed at twelve to twenty-one days, fourteen to eighteen covering most of the cases.

Invasion Period.—The first symptom seriously complained of is often the rash itself, but if careful inquiry is made it will appear that in a considerable proportion of cases an ill-defined prodromal period exists. The length of this period is usually short; in rare instances only does it exceed three days, and its limits may be fixed at from twelve hours to a week. The most frequently noticed symptom is *slight catarrh*, evidenced by occasional coughing and sneezing. There is seldom actual running at the eyes or nose. Some slight degree of sore throat is not infrequently complained of, and headache, seldom severe, may also occur. The patient is perfectly able to do his work, but is conscious of more or less malaise. Vomiting, though it sometimes occurs, is very rare.

The most suggestive feature, however, of the prodromal stage is the enlargement which in about one quarter of the cases has already made itself obvious in the cervical and suboccipital glands. This may be well marked enough to cause a sensation of *stiffness of the neck*. This symptom occurring in an exposed person gives an opportunity for early isolation. In schools and hospital wards, where a case has occurred, all the prodromal symptoms mentioned above should be carefully watched for, and in this way the opportunities for infection may be much limited.

Stage of Eruption.—It is the appearance of the *rash* which in most cases leads the patient to seek medical advice. The face is usually first affected, spots appearing on the brow and behind the ears. The individual spots are considerably larger than the punctate spot of scarlatina, and, even in the most profuse rashes, much less closely set together. On the other hand, they are more definitely circular and much less raised than the measles papule, and in most instances they are distinctly smaller. There is much

less tendency than in measles for the spots to coalesce into irregularly shaped macules, although occasionally the rash on the face and forearms may present quite a blotchy appearance. Should this be the case, the resulting macules are much less elevated than in measles, and can only seldom be appreciated by the finger. As regards the *colour* of the eruption, it is either a pale pink or a somewhat "faded" red. It has neither the brilliance of the red of scarlatina nor the dusky or somewhat bluish pink tint of measles. In *distribution* we have seen the face is first affected, and the circumoral region is invariably well spotted. From the face the rash spreads rapidly over the trunk and limbs, the dorsum of the foot being the last place reached. At first the spots remain quite distinctly discrete, and their circular shape is usually well seen. In from twelve to twenty-four hours, however, there is a tendency for a marked change to occur both as regards the character and the apparent distribution of the eruption. The spots fade from the face, and unlike measles no definite staining is left to prove that they have been present there. On the body the rash becomes more profuse and the individual spots less distinctly defined, the result being a not bad imitation of a scarlatinal eruption, an effect which may be enhanced by a flushed face and a clear circumoral ring. The extremities at this stage may present either a scarlatiniform or a roughly morbilliform type of rash. A patient suffering from rubella, indeed, seldom shows at this time an eruption which presents the same appearances all over the body at once. There are also apt to be differences of intensity in different parts of the body. The rash is seldom equally bright over the whole skin surface at the same moment. This multiform character has its importance as regards diagnosis. Itching is sometimes complained of,

but is not as frequent as some authorities would suggest.

It will be seen from the above, then, that the rash of rubella is liable to call to mind both that of measles and that of scarlatina. On the first day it more nearly resembles the former. On the second day it approaches more closely to the appearance of the latter. Some rashes, however, never become scarlatiniform. On the other hand, the scarlatiniform type is said to be the most common in certain epidemics. But there is every reason to believe that if the rash is seen from the first it will pass through the stages described above in the vast majority of cases, although in adults with weather-beaten or sunburnt complexions it may never be visible on the face at all. As regards its *duration*, an average period of eruption would last from twenty-four to thirty-six hours. Its limits are roughly from twelve hours to four days. It has a tendency to almost disappear and then come out again, and is brightest on parts of the body kept warm, as in the neighbourhood of a hot bottle.

The *other symptoms* are trivial. The catarrh is extremely slight. The eyes are often injected, but there is no lachrymation, nor is there photophobia. There is some mild congestion of the fauces, and the majority of patients complain of slight sore throat. The palate is occasionally indistinctly spotted, the spots being sometimes very minute vesicles. The buccal mucous membrane remains normal, and presents a great difference from that seen in measles. The tongue presents no special features.

The *temperature* is in most cases elevated, but only to a very slight degree. Even in young children the highest level reached is usually not more than 100°, and this is seldom maintained for more than a few hours. In adults the highest figure reached may be only 99°, and some patients have no fever at all.

The pyrexia in any case is quite disproportionate to the amount and brilliance of the rash. The patient, moreover, feels reasonably well, and it may be difficult to persuade him to remain in bed. The malaise naturally has some relation to the amount of the fever, and in those rare cases where levels of 102° or over are attained the patient may feel miserable enough.

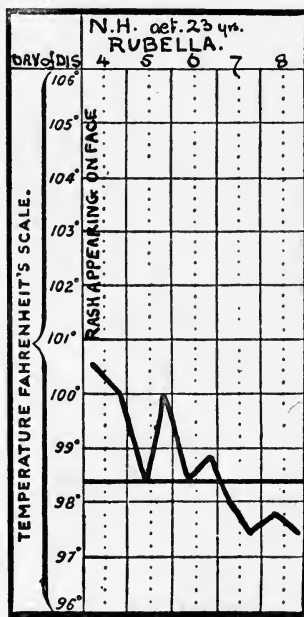


FIG. 5.—Rubella. Showing temperature from the onset of the rash.

The enlargement of the *glands*, as we have seen, is quite often obvious in the prodromal period. By the time the rash has appeared it is always to be recognized. The glands most constantly affected are those lying along the posterior border of the sterno-mastoid muscle where they may sometimes be seen and can always

be palpated. They are felt as a chain of bullet-like masses, rolling easily under the finger, and not matted together or inflamed. They may be slightly tender, but tenderness is by no means an invariable symptom. The glands at the angle of the jaw are frequently enlarged, and still more characteristic is enlargement of the suboccipital glands, which sometimes swell to an extraordinary extent. The mastoid glands are often, but not always, affected. The axillary group usually suffers, and often affords the most reliable evidence of glandular enlargement due to rubella. The inguinal glands are also frequently involved. Suppuration never occurs, and the swelling subsides as rapidly as it has appeared, the glands often regaining the normal by the time the eruption has disappeared. In rare instances the enlargement of certain glands seems to be permanent.

The *urine* presents no special features. Albuminuria is practically unknown, and the diazo reaction does not occur in one per cent. of the total cases.

The *blood* seldom shows a leucocytosis. The lymphocytes average about 55 per cent. Large mononuclears are relatively numerous, and eosinophiles very rare.

Period of Desquamation and Convalescence.—After the rash has faded there is as a rule no staining observed. There is usually some slight desquamation, often best marked on the face, and not affecting either the palms or soles. It is complete in about ten days. The disease both in its eruptive and convalescent stages shows a remarkable freedom from *complications*. Rubella differs from the other infectious diseases in this respect, and such conditions as otitis media, nephritis, or broncho-pneumonia should always cast a doubt upon the diagnosis. *Relapses* undoubtedly occasionally occur. Second attacks, on the other hand, seem to be very rare.

Types.—Although morbilliform and scarlatiniform varieties of the disease are often spoken of, we have seen that in most cases the disease runs a fairly constant course even as regards the skin appearances. Mild types without rash and limited to slight catarrh and injected conjunctivæ have been described, but the rash is sometimes so evanescent that it might well be missed altogether in an exceptional case. A severe type also, in which laryngitis and bronchitis are frequent complications, has been said to occur. There is reasonable cause for doubt, however, whether this condition was in reality rubella, as it differs from all accepted conceptions of it.

Prognosis.—This is invariably favourable. No patient ever succumbs to rubella.

Diagnosis.—The only difficulty will be with the first few cases observed. But if scarlatina or measles, or both, are epidemic when the first cases come under observation, the diagnosis is not an easy one. It is from these two diseases particularly that we must distinguish rubella. If they can be eliminated, all we have to consider is its differentiation from adventitious and drug rashes.

It is on the second day of the eruption, or at least some twelve hours after it has appeared, that the disease is liable to be confused with *scarlatina*. By that time the face is free of spotting, the circumoral region clear, and the rash diffuse on the body. As regards the appearance of the patient, the conjunctivæ in rubella are often pink, a condition only likely to be met with in severe scarlatina, which it is not possible to confuse with the milder infection. The rash when carefully examined will often show a definite discrete circular spotting, especially in the situations where it is freshest, for instance on the dorsum of the foot, which should always be examined. The extremities, again,

may show a morbilliform arrangement which should make the diagnosis clear. The colour of the rash, moreover, seldom has the true scarlet tint. The extreme mildness of the symptoms, the trivial pyrexia, and the absence of enlargement in the tongue papillæ are points of importance ; but nevertheless the fact that true scarlatina may occasionally assume a very mild type must never be lost sight of. Even slight coryzal symptoms, such as sneezing, should suggest rubella in a doubtful case, and a history of this or, as can often be elicited on inquiry, of a definite rash having been noticed on the face earlier in the attack points in the same direction. Marked enlargement of the glands, and above all a complaint of stiffness of the neck, are also in favour of a diagnosis of rubella.

Perhaps the differentiation from a mild attack of *measles* is even more difficult. A well-marked prodromal stage with obvious coryza suggests measles, the corresponding stage of rubella seldom causing much complaint on the part of the patient. Stiff neck is not complained of in measles, though occasionally the glands may show considerable enlargement. The conjunctival symptoms of measles are always more marked, and the cough even in very mild cases more troublesome, than in rubella. While the rash on the face and extremities in rubella is often blotchy enough to resemble that of measles, the trunk only seldom shows a measly appearance, the rash there being either generally diffuse or, if remaining discrete, preserving its isolated circular spots which show little tendency to coalesce into macules in this situation. When the rash of true measles runs together into a diffuse redness, we may be fairly certain the other symptoms of the disease are extremely well marked, and unlikely to be mistaken for rubella. The complete absence of staining as the eruption fades from the face and its

tendency to assume a multiform character are strong arguments in favour of rubella. It is usually on the first day of eruption that the confusion between the two diseases occurs. As with scarlatina, the more severe the symptoms, the less likely are they to be due to rubella.

As a final court of appeal, the buccal mucous membrane should be always examined. Even on the first day of eruption in measles, Koplik's spots, or at least marked congestion, may be detected in this situation. The membranes in rubella remain practically normal, and Koplik's spots do not occur. In very difficult cases the presence of the diazo reaction in the urine when the eruption is commencing to fade should turn the scale in favour of measles. A lymphocytosis, as against a high percentage of polymorphs, on the other hand, suggests rubella.

In distinguishing rubella from various adventitious *rashes*, we must remember those caused by drugs, articles of diet, enemata, and serum. These eruptions tend, like that of rubella, to be multiform, but they have a much greater liability to present urticarial or circinate arrangements, both of which are very rarely, if ever, seen in rubella. A history of catarrh, however slight, or of stiff neck, would clear up a doubtful case. Some trouble may be met with in young children with so-called "teething" rashes. Here we would expect no glandular enlargement. As long as we remember the possibility of rashes due to these causes, and make appropriate inquiries, the diagnosis is not likely to be difficult.

Considering how invariably glandular enlargement occurs in rubella, it is perhaps illogical not to lay greater stress upon it in differentiating the disease from the conditions confused with it. But it must be remembered that both in measles and scarlatina the

cervical glands are often large, and what is more important still, the occipital and mastoid glands may in healthy children show considerable enlargement as the result of vermin in the hair and other scalp irritations. For this reason the axillary glands form the safest guide, the inguinal being often swollen as the result of uncleanness of the genitals. But except in very good class practice too much weight must not be laid on the mere presence of glands.

Treatment.—There is little to be said on this point. The illness is so trivial that treatment is scarcely required. It is sufficient to keep the patient in bed while pyrexia persists, or for a day or two after the rash disappears. If the fever is considerable, a most unlikely occurrence, appropriate light diet should be ordered. In the average case the patient preserves his appetite and can enjoy ordinary food. The glands require no treatment, but the neck may be made comfortable by wrapping it up in cotton wool.

Isolation.—One week is amply sufficient. It is very questionable, indeed, if the infection lasts so long.

Prophylaxis.—The infection is short-lived, and is apparently destroyed by ordinary domestic cleaning. Disinfection is scarcely necessary, but the rooms occupied by a patient should be well cleaned and aired. In school outbreaks it is worth considering if it is necessary for contacts to undergo the full *three weeks' quarantine* which the long incubation period of rubella suggests. It would be simpler to let contacts attend school for the first ten or twelve days after exposure, only isolating them during the dangerous period, from twelve to twenty-one days from the supposed infection. In this way much school time could be saved which is too often wasted. No quarantine should be imposed on persons who have had the disease before.

The Fourth Disease.—The question has arisen as to whether a “fourth disease,” that is to say an infection distinct from the three usually recognized—scarlatina, measles, and rubella—may not also exist. Dr. Dukes of Rugby has described three outbreaks of an infectious exanthem to which he has provisionally given this name. The symptoms ascribed to this illness were a bright scarlatinal rash which spares the face, a swollen throat, some enlargement of glands, with moderate pyrexia and pink eyes. The incubation period was from nine to twenty-one days. Desquamation usually occurred, and occasionally was as profuse as in scarlatina itself.

It may be said that the best authorities have not accepted Dr. Dukes’ theory, and deny that a Fourth Disease exists. It is possible that, in some of the outbreaks which have been described, mild scarlatina was in reality the disease. In others, undoubtedly, ordinary rubella seems to have been unrecognized. But with the evidence at our disposal it would be going too far to say that a fourth exanthem does not exist. Whether, when it is isolated, it will correspond with Dr. Dukes’ description, or whether its symptomatology will not rather resemble that of mild measles, is another question. There is no doubt that we are occasionally confronted with rashes which quite defy classification.

CHAPTER V.

SCARLET FEVER.

Etiology.	Stages of Defervescence, Desquamation, and Convalescence.
Dissemination.	Types of Scarlet Fever.
Infectivity.	Relapses and Second Attacks.
Morbid Anatomy.	Complications.
Period of Incubation.	Diagnosis.
Stage of Invasion.	Prognosis.
Stage of Advance and Eruption.	Treatment.
The Eruption.	Isolation.
The Throat.	Return Cases.
The Tongue.	Prophylaxis.
Other Symptoms.	

Synonym—Scarlatina.

Etiology.—There is no doubt that scarlet fever is due to infection by a micro-organism, but at present the *bacteriology* is most uncertain. There is, however, a considerable amount of evidence in favour of a streptococcus. In 1885, Klein isolated this form of micro-organism from scarlet fever patients and also from some cows which suffered from an eruptive disease of the udder, and the milk of which was under suspicion. More recently Gordon found that two forms of streptococcus existed in the throat of scarlet fever patients, one the ordinary *Streptococcus pyogenes*, and another which presented peculiar cultural distinctions, prominent among which were its capacity for coagulating milk and its tendency to conglomerate in broth cultures. This micro-organism, under the

name of the *Streptococcus scarlatinae*, or *conglomeratus*, is accepted by many as the actual cause of the disease, and its differentiation from *pyogenes* has been quite recently confirmed serologically by agglutinin absorption tests. It must be remembered, however, that secondary infection with ordinary pyogenic streptococci is a feature of many of the worst cases of scarlet fever, and it is quite possible that the *Streptococcus conglomeratus* also plays a secondary part. Mair has recovered a *diplococcus* from the throats of 87 per cent. of scarlet fever patients examined, and has succeeded in producing in monkeys a condition resembling scarlet fever. It is not improbable, however, that the unknown cause of the disease will ultimately be found to be an ultra-microscopic filter passer.

The disease occurs in epidemic waves, and is endemic in most of our large cities. It does not appear that *climate* exercises much influence, but the fever is rare in Asia and Africa. The most usual *season* for its prevalence is the autumn, the crest of the wave being reached in October, while the early spring months furnish the smallest number of cases. As regards *age*, scarlatina chiefly attacks the young, but at a slightly later period of life than is the case with measles or whooping-cough. Infants do not contract it readily, but from the second year the number of cases rapidly rises until the maximum is reached in the sixth. Roughly speaking, it is the second five years of life which show the greatest number of cases. Adults may be attacked, but nevertheless only a small proportion of the total number of patients are over fifteen years of age, and after fifty the disease is rare. Little influence is exercised by *sex*, but perhaps females are attacked slightly more frequently than males. It is probable that throat conditions predispose to scarlet fever, and the suscepti-

bility of diphtheria convalescents seems undoubted. It is said that puerperal women are peculiarly liable, but this is doubtful.

Dissemination. — Direct *contact* from person to person is the most usual manner in which the fever is contracted. The virus is no doubt contained in the faucial and nasal secretions of infected individuals. The infection can be carried by a healthy third person, perhaps on the clothes, or possibly even in the throat. There is no reason to doubt, indeed, although it is at present impossible to prove, that the healthy "carrier" of organisms may play the same part as is the case in diphtheria. *Fomites* appear to be of considerable importance in disseminating the infection, and clothing, bedding, and so forth may retain the virus for long periods. Crockery, spoons, and throat instruments are also liable to carry infection. Some outbreaks depend upon infected *milk*. In most cases the milk is contaminated by a worker in the dairy, but it has been suggested that occasionally the infection comes from the cow. At Hendon, in 1885, an epidemic was believed to be caused by milk, and it was found that the cows suffered from an eruptive disease of the udder. As we have seen above, Klein obtained streptococci from these cows, and the presumption was that on this occasion the cows originated the outbreak. More recent observations, however, have cast great doubt upon the specificity of "Hendon disease." There is no reason to believe that water ever spreads scarlatina, and there is no evidence that the infection is carried by air. It is said that domestic animals sometimes assist in its dissemination either as "carriers" or by actually suffering from the disease. It has recently been observed that the seasonal curve of the fever coincides with that of the prevalence of *fleas*, but it seems very improbable that the disease can

be transmitted by vermin. As regards *schools*, they do not play the important part which they do in measles or diphtheria.

Infectivity.—The patient is infectious from the moment of the first symptom, and the infectivity is probably highest at the height of his fever. It is quite impossible to say when infectivity ceases. We have reason to believe that the virus lies chiefly in the throat and nose, as in the case of diphtheria, and on the analogy of this last-named disease we would expect that in a certain number of cases it may be a very long time before the faucial secretions become free of germs. On the other hand, it is equally probable that in many instances the infective organisms disappear from the throat, as in diphtheria, in two or three weeks, and it is doubtless due to this that the discharge of patients after three or four weeks' hospital detention, as is practised in some towns in England, can be carried out with comparative impunity. Formerly it was held that the desquamated skin was the chief source of infection. That idea is no longer entertained, though we must admit that as long as the patient himself remains infectious he is as capable of infecting his cuticle as he is his clothes. But once his infection is over, there is no reason to believe that flakes of skin from his hands or feet are dangerous in themselves. Infectivity is, on the other hand, prolonged almost indefinitely by inflammatory conditions affecting the nose, throat, or ear, and it is wise to regard every convalescent who suffers from any purulent discharge as potentially infectious even if isolation has been practised from twelve to eighteen weeks or longer. Until we can demonstrate the presence or absence of the causative organism in our convalescents, we can have no absolute feeling of security. In the meantime a detention in hospital of from four to six weeks from the date of the

first symptom may be regarded as an adequate precaution, except in the case of patients suffering from catarrhal or purulent conditions.

Morbid Anatomy.—In the case of those who die early in the disease from toxic scarlatina there is but little to be seen post-mortem except the changes common in all fevers. The blood is dark and fluid. In septic cases there is usually more or less bronchopneumonia, and pus can be squeezed from the smaller tubes. Endocarditis and pericarditis are occasionally observed. The characteristic scarlatinal lesion is the inflammatory change in the *kidney*, but this is often wanting. When nephritis has contributed to death the kidney is found to be increased in size, and the capsule strips readily. The cortex is pale, somewhat enlarged, and often fatty. The Malpighian bodies appear as yellowish dots. On microscopic examination the principal changes are seen in the glomeruli, but the interstitial tissues are always to some extent affected. The tufts are congested, and there is proliferation of the cells lining the capsules and the tubules. The tubules themselves are filled with cells. The general infiltration of the tissues with leucocytes also helps to obstruct them.

Period of Incubation.—This is usually short, and in most cases is probably from two to three days. It has been stated that in some instances the period lasts only a few hours, but anything under twenty-four must be extremely rare. As an extreme maximum we may take six days, but any period which lasts over four must be regarded as most unusual.

Stage of Invasion.—This may be said to last from the moment of the first symptom till the rash appears. The stage is a short one, seldom exceeding twenty-four hours, but occasionally lasting for a day longer. The onset is sudden, and the temperature

in an average case rises rapidly from the first. Accompanying this pyrexia three symptoms are usually present which should always cause scarlatina to be suspected—*headache, vomiting, and sore throat*. In mild cases one or more of these signs may be missing, and vomiting is not nearly so frequent in adults as it is in children. Feelings of chilliness and shivering are not uncommon, and the patient suffers from all the ordinary symptoms of fever. The *pulse* at this period is often accelerated quite out of proportion to the amount of pyrexia present, and this is a suggestive sign in diagnosis. The throat is congested, and often a punctate spotting may be visible on the soft palate.

In severe cases of the toxic type the vomiting may be persistent, and diarrhoea may also be present. In mild cases the prodromal symptoms are trivial, and the rash itself is sometimes the first obvious symptom.

Stage of Advance and Eruption.—The description which follows refers to the average case of scarlet fever, the so-called *scarlatina simplex*. The stage may be said to last from the moment the rash appears until it commences to fade, that is to say from twenty-four hours to four days. The *temperature*, which has risen rapidly in the preceding stage, has reached the level at which it will remain during the period of eruption, that is to say something between 101° and 104° . The latter figure may be exceeded in sharp cases. The pyrexia is maintained without much remission while the rash lasts, and subsides with its disappearance. The *pulse*, at first unduly rapid, usually regains its ordinary ratio to the temperature after the first twenty-four or thirty-six hours of the eruption. The respirations are not particularly accelerated. The *facies*, especially in children, is highly characteristic. The face is brightly flushed, the colour concentrating itself

on the cheeks. The flush is uniform in appearance, and shows none of the punctation of the actual rash. The area surrounding the mouth and nose stands out pale against the flushed background. This *circumoral pallor* appears to depend upon some vasomotor action

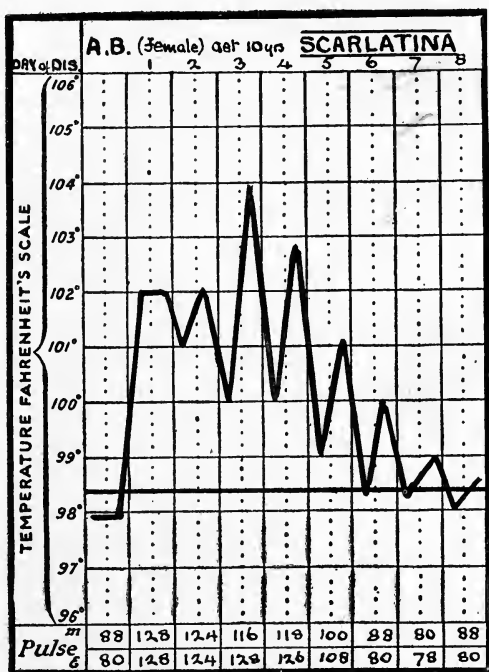


FIG. 6.—Simple Scarlatina. Showing abrupt onset and rapid lysis.

and is not merely the result of contrast. It gives a very typical appearance to the face, and, although sometimes imitated in the lobar pneumonia of children, should always suggest scarlet fever. It is not, however, well marked in adults. The eyes are clear, and the conjunctivæ are only injected in very severe cases. The expression is, as a rule, intelligent.

The Eruption.—The rash is usually obvious within twenty-four hours of the onset of symptoms. It appears first on the sides of the neck and on the upper part of the chest, spreading downwards over the trunk and extremities. The whole body may be covered in a few hours. As it appears so it fades, the last traces of it being often to be found on the legs.

The *distribution*, then, is general, except in so far that the face does not participate in the general punctuation. The most that is usually to be seen in this situation is some punctate spotting in the neighbourhood of the angle of the jaw. The palms and soles, moreover, though flushed, seldom show definite punctuation, except perhaps on the thenar and hypothenar eminences of the former. The back of both hands and feet, however, is invaded by the rash.

As to the *character* of the eruption, it consists of closely set minute points, usually of a brilliant red colour, upon a paler but often flushed background. In mild cases the spots are pink and the background is pale. The individual punctate spots almost touch each other. They may vary somewhat in size, but on an average will hardly exceed half the diameter of the head of an ordinary pin. Their margin is not always too clearly defined, but in intense rashes tends to blend almost imperceptibly into the subjacent erythema. The spots are not appreciably raised above the surface, and are obliterated easily by light pressure. The pattern of the hand, firmly pressed on the skin, is left for a few seconds standing out dead white on a brilliantly red background. It may be mentioned that the skin often feels pungently hot to the touch.

In most cases the rash is uniform, but it is often better marked in some situations than others. Thus it is usually very well developed on the back, although its punctuation may not be very distinct there. The

PLATE II.



THE ERUPTION OF SCARLET FEVER.

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abdomen and inner side of the thighs will often show a brighter and more definitely punctate eruption than some other parts. On the extremities the rash in some cases tends to be blotchy, the lesions showing a certain tendency to irregular distribution and grouping. Again, in rough-skinned persons particularly, the spots appear to be slightly raised above the skin on the arms and legs. This gives a suggestion of fine papulation to the rash. The raised skin papillæ may retain their hyperæmic appearance after the rest of the rash has faded, and this point is often of importance in diagnosis.

The rash varies in its *intensity* according to the severity of the case. When it is extremely brilliant it may become "miliary," the individual puncta becoming crowned with tiny vesicles containing a yellowish fluid, and the whole surface of the body, and often of the extremities, is, as it were, peppered with minute yellow spots on a dark red background. The rupture of these miliary vesicles gives an explanation of the mechanism of desquamation. It leaves a little "pinhole" breach in the cuticle, and we can well believe that what occurs macroscopically in a miliary eruption also takes place microscopically in the hyperæmic skin papillæ of the typical rash. In other patients the intensity of the eruption is evidenced by the occurrence of slight hæmorrhage into the punctate spots, which become darker and purple in colour, and no longer disappear on pressure. Such spots may remain visible for some time after the subjacent erythema has faded. Even in moderate cases, however, some degree of *staining* survives the rash. In the flexures of the joints, particularly in the fold of the elbow, a dark red line is often left transversely across the limb, not fading on pressure but well stained into the skin. This line may be of great assistance in the diagnosis of a doubtful

case. The *duration* of the rash as apart from staining seldom exceeds four days. In very mild cases it may last for only a few hours.

The Throat.—The punctation of the soft palate which so often precedes the rash has already been alluded to. It is usually fairly obvious on the first day of eruption. The fauces are always congested and hyperæmic, and the bright red colour is often very suggestive of the fever. This *congestion* is sometimes all that is to be seen, but many cases show considerable *œdema*, and the colour of the mucous membrane of the fauces is darker and more plum-coloured. The tonsils almost meet, and are occasionally enormously enlarged, and much sticky mucus clings to their inner surfaces. Suppuration, however, is uncommon. Swallowing is very painful, and in rare instances the œdema may be sufficient to embarrass the breathing. In other patients who present much less swelling the tonsils may be patched with *exudation*. A yellowish scum, usually quite easily detached, patches the mucous membrane and clings to the crypts. Its removal by swabbing does not cause bleeding, and leaves no obvious abrasion behind it, but it is extremely apt to recur. Occasionally in septic cases this patching goes on to *ulceration*, a process which may involve not only the tonsils but also the pillars of the fauces and even the soft palate itself. Necrosis with perforation of the palate is a not uncommon sequela in the worst type of septic case.

The Tongue.—The chief obvious changes are the œdema and enlargement of the papillæ and the progressive desquamation of the fur. The appearances observed succeed each other in regular gradation and can be predicted with confidence. For convenience of description a certain type of tongue may be assigned to each day of the illness in an average case, it being

understood that in certain patients the changes described occur somewhat more rapidly or more slowly than is usually to be expected. On the *first day* creamy white fur quickly accumulates on the tongue, which is thickly plastered white. During the *second day* swollen and prominent papillæ begin to protrude through the fur, and the appearance presented is that of numerous bright red dots on a white surface. This type of tongue has been called the "white strawberry" tongue, and is met with in many other conditions besides scarlet fever. Even on the second day the desquamation of fur has usually commenced, the tip and edges of the tongue being often clean and of a vivid red colour. On the *third day* the desquamative process is still further advanced, the fur peeling off in strips from before backwards, and leaving what may be called a "transition tongue," presenting in different areas the features of both white and red strawberry types. By the *fourth day* desquamation is usually complete, and the typical tongue of scarlet fever, the "red strawberry" tongue, is seen. It is quite clean and raw, the colour is deep red, and the papillæ all over the surface are prominent and often oedematous, the fungiform papillæ being particularly well marked. This type of tongue is often recognizable for several days after the fourth, although the papillæ lose their prominence and the colour gradually regains the normal. Fur, however, is slow to appear. It must again be repeated that, while these stages succeed each other, as described, in the vast majority of cases, the desquamation is more rapid in some than in others, and it may be added that adults seldom show such typical tongues as do children.

Other Symptoms.—While the sore throat persists it is usual to find the *glands* below the angle of the jaw somewhat enlarged and tender. Great glandular

swelling, however, only occurs in septic cases. The *digestive system* is always more or less deranged. The appetite is lost, and young children suffer much from thirst. The bowels are usually constipated, though a little diarrhoea may be present at the onset of the fever. Vomiting, which, as we have seen, is a frequent initial symptom, sometimes persists for one or two days, even in comparatively mild cases. In simple scarlatina severe *nervous symptoms* are not to be expected. Convulsions may precede the rash in a few instances, headache may be persistent, slight delirium is not uncommon at night, and the sleep is often restless and broken.

The *urine* in the eruptive stage is scanty and high-coloured. If there is much pyrexia, some slight degree of albuminuria is not uncommon, and need not be regarded seriously. In sharp cases the diazo reaction is frequently present. The *blood* presents a well-marked leucocytosis which depends upon an absolute and relative increase in the number of polymorphonuclear cells. Eosinophiles occur in comparatively large numbers shortly after the onset of the fever, and a high percentage may be maintained to the end of the first week. In severe cases the blood is very fluid and coagulates slowly.

Stages of Defervescence, Desquamation and Convalescence.—The *temperature* regains the normal by a rapid lysis, taking from three to five days to subside. In rare instances a critical fall may terminate the fever. With the subsidence of the pyrexia the rash, as has been noted above, fades, and in most cases the sore throat rapidly improves. By the end of the first week of illness it is reasonable to expect to find the temperature normal, the rash disappeared, and the throat free from congestion.

Desquamation is occasionally visible in well-marked

cases before defervescence has commenced, the face presenting a fine powdering which on the brightly flushed cheeks gives a suggestion not unlike that of "rouge and powder." In a more average case the first signs of desquamation are noted during defervescence on the lobes of the ears and the sides of the neck. From the latter situation the process spreads over the trunk and limbs. Regular peeling must not be expected in every case. Very often the cuticle separates as an almost imperceptible powder, or is rubbed off by the towel after the nightly blanket-bath or tub. This is particularly the case in infants. The most characteristic type of desquamation is the formation of small pinhole breaches in the cuticle which, by increasing in size and coalescing, detach large or small flakes of skin. This is best seen on the neck and chest, and on the outer surfaces of the arms, forearms, and thighs. The skin of the legs is more apt to show coarse powdering. The peeling of the palms and soles is, even in mild cases, usually fairly obvious.

Desquamation occurs in the following sequence. By about the seventh day the ears, neck, and upper part of the chest show evidence of skinning. The trunk and arms follow, and at the end of a fortnight the skin of the hands begins to split in a line with the free edge of the nail. During the third and fourth weeks the desquamation of the fingers and palms is usually well marked. Not infrequently, skinning of the hand is not completed till the end of the fifth week. The toes begin to split about a week after the fingers, towards the end of the third week or a little later. The last skin to be detached is that of the heel, and desquamation may not be complete in this situation till the end of the seventh week or later. In a fair number of cases, however, all skin has separated by the end of the sixth week. In certain patients a

secondary desquamation may occur, particularly affecting the hands and feet.

The history of desquamation is the history of convalescence. The latter commences with the return of the temperature to normal. It is apt to be interrupted by complications, but should these not present themselves the patient rapidly regains strength.

Types of Scarlet Fever.—The type so far described is that of average scarlet fever, the so-called *scarlatina simplex*. But the disease may occur in a less obvious form, and **mild types** are not uncommon in some epidemics. The symptoms are trivial, the pyrexia slight or altogether absent, and the rash evanescent. Some patients, however, may present a brilliant rash and characteristic tongue with a complete absence of fever. While any of the usual signs of the disease may be wanting the pulse is generally unduly accelerated for the first twelve or twenty-four hours, a point of great importance in diagnosis. The **severe types** are liable to occur in any outbreak of the disease, and are responsible for the greater part of the mortality. Two main varieties are distinguished, the toxic and the septic. By **toxic** scarlatina we understand those cases which were formerly called “scarlatina maligna,” and the severity of which appears to depend on the toxins of the micro-organism which causes the disease. The main characteristics of the toxic type may be summed up as very severe general symptoms, associated with only moderate faucial lesions and progressing to a fatal termination.

The toxicity of the case is manifested in a variety of ways. In some instances a patient succumbs within twenty-four hours, having presented symptoms compatible with irritant poisoning, such as continuous vomiting and purging. A history of exposure, a slight sore throat, and perhaps the suggestion of a rash may be the only facts pointing to scarlatina in a *fulminant*

case of this type. More commonly the patient survives from two to five days. The rash is scanty, badly developed, or of a bad colour, and its appearance may be delayed. The temperature is usually high, often over 105° , and rises to hyperpyretic levels before death. The pulse is rapid, and ranges from 140 to 160 or over. The throat is in most instances no worse than that of an ordinary simple case. Vomiting may be persistent, and diarrhoea is common. The nervous system often suffers severely, as is evidenced by delirium, insomnia, subsultus of the tendons, and picking at the bedclothes. Such cases are called *ataxic*, and are usually accompanied by hyperpyrexia. Other patients in whom the heart appears to suffer most have a lower temperature and less marked nervous symptoms, and are classed as *adynamic*. The failing heart is suggested by the pale face and cyanotic scanty rash. In both types hæmorrhage may occur into the punctate spots, which become petechial and cease to fade on pressure. Too much stress, however, need not be laid upon distinction of type. The process is the same, the toxins apparently attacking the most vulnerable tissues in the patient and presenting as a result different symptoms in different individuals.

In **septic** scarlatina the symptoms appear to be due to a secondary infection with pyogenic organisms, and the death which so frequently follows is the result of septicæmia rather than of infection with scarlatinal germs. In this type, which is responsible for the vast majority of deaths attributed to scarlet fever, the throat symptoms are often very severe from the first. It is quite possible, however, for an ordinary "simple" case of the fever to contract secondary septic infection as long as the throat remains congested and in a suitable condition for the reception of extraneous organisms.

The rash is usually well developed, and is of a good

colour, but is apt to be blotchy, especially on the extremities. The temperature, which is always high, 103° to 104° , does not fall with the disappearance of the rash, but remains elevated as long as the septic process continues. The pulse is rapid. The throat remains swollen and painful, and ulceration to a greater or less degree is always present. The nasopharynx becomes involved in the inflammation, and an acrid, watery discharge, which becomes rapidly purulent, pours from the nostrils. There is much soreness and excoriation

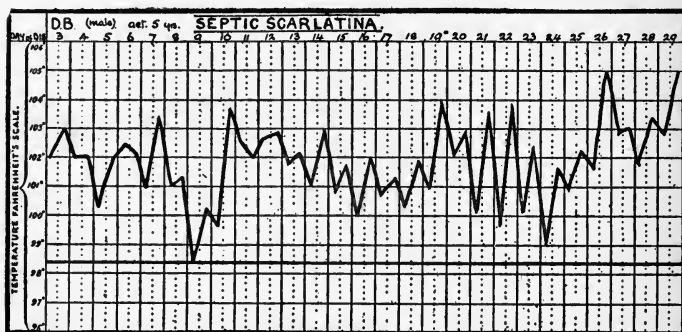


FIG. 7. —Septic Scarlatina. Terminating fatally on 29th day.

of the upper lip, and if the patient's hands are left uncontrolled it is not unusual to see pustules, caused by inoculation of the discharge, on the rest of the face. The glands, enlarged from the first, increase in size till a collar is formed round the neck, extending from the lower jaw to the clavicles. The middle ear is soon affected, and otorrhœa appears early on one or both sides. Arthritis is a not infrequent complication. The difficulty and pain in swallowing are often very great, and it is possible that the broncho-pneumonia which is sometimes observed in the second week and later is due to particles of food entering the respiratory passages. The patient is acutely uncomfortable, and is

always restless and resistive. Occasionally blotchy rashes of a septic nature may appear on the limbs, particularly in the neighbourhood of the joints. Sometimes these rashes invade the face, giving quite a measly appearance to the patient. Towards the end in a fatal case albuminuria is common, and there may be some diarrhoea. The pulse and respirations are accelerated, and the temperature tends to rise.

The fever is usually prolonged. In favourable cases, it is true, it may subside in ten days or a fortnight, but a duration of from three to four weeks is more probable. Death may occur at almost any period, but very commonly in the third week. By this time it is usual for extensive necrosis to have occurred in the throat, and perforation of the palate or pillars is relatively common. Should the patient recover, convalescence is slow, and is interrupted by accesses of fever due to the condition of the ears or to suppuration in the glands. Septic scarlatina is seen chiefly in young children.

Other Types.—These need only be mentioned. There is a form of scarlatina, probably due to sepsis, but unaccompanied by severe throat lesions, which runs a *typhoid* course, the patient resembling one suffering from enteric fever. In such a case the pyrexia is like that of enteric, being remittent in character, and the spleen may be appreciably enlarged. The type may be summed up as presenting continued pyrexia after the rash has disappeared, with no obvious local cause for the fever. By *surgical* scarlatina is understood the mild type of the disease which occurs with such comparative frequency after certain injuries, particularly burns. In some alleged cases the rash is probably septic, but others are instances of true scarlatina of a modified type. By *traumatic* scarlatina is meant a case in which the infection has been apparently contracted through a

wound, as for instance a prick in the finger in opening suppurating scarlatinal glands.

It has been held that women in the puerperium are particularly liable to contract scarlatina, but this is probably not the case. Again, it has been stated that *puerperal* scarlatina is particularly dangerous. This is also open to question, although the occurrence of the fever in a puerperal woman may well cause anxiety. There is no reason to believe, however, that scarlet fever will cause puerperal sepsis. The disease breeds true, and if reasonable care is taken the lacerated genitals should escape infection. In pregnancy scarlatina is not especially severe; and abortion is not common.

Relapses and Second Attacks.—The scarlatina patient is more likely to suffer from a *relapse* than is the convalescent from any of the other exanthemata. By a relapse is understood a repetition of the original attack with all its classical symptoms, usually in a milder but occasionally in an equally or more severe form. The fourth week is the most probable time for such a relapse to occur, but it may be deferred till later. It is doubtful whether a true relapse occurs in more than one in four hundred cases. *Second attacks* are comparatively common, and even third attacks have been known to occur. In the vast majority of cases, however, an attack of scarlet fever protects for life.

Complications.—During the desquamative period certain complications are very liable to occur, some showing a preference for a particular stage of convalescence, others appearing at almost any time during the patient's isolation. The most important, and the most characteristic of scarlet fever, is **nephritis**, which is apt to occur at the end of the third or the beginning of the fourth week, a high percentage of the cases appear-

ing between the sixteenth and the twenty-sixth days of the disease. With nephritis may be classed the late *albuminuria* of scarlatina, which only differs from the more severe condition in degree, and should always be regarded seriously. The kidney inflammation has been attributed to invasion of the organ by streptococci but is more probably due to the excretion of a toxin, whether that of the disease itself, or, as has been recently suggested, that which possibly results from the interaction of germs remaining in the kidney tissues and anaphylactic reaction bodies. It occurs quite independently of the severity of the original attack; indeed, it is often after mild and unrecognized cases that we see the worst examples of nephritis. Although it is a disputed point, it is probable that cold, damp weather and exposure to cold draughts of air predispose to the condition. The patients most liable to be affected are those in the second five years of life, and the most frequent age is from five to seven years. After the age of ten years, while albuminuria is fairly frequently met with, acute nephritis is rare. Taking albuminuria and nephritis together, the kidney complication appears in less than 10 per cent. of the patients treated.

One of the earliest *symptoms* of nephritis is often vomiting, the mere occurrence of which in the convalescence of scarlet fever demands an immediate examination of the urine. In other cases irregular pyrexia, œdema, or more rarely convulsions, first call attention to the existence of the condition. The detection of albumin in the routine examination of the urine may be, on the other hand, the first warning.

From the first the *urine* is scanty. Sometimes it is entirely suppressed. It usually contains blood, the amount of which varies in quantity, the colour being anything from very slightly smoky to dark reddish brown. Epithelial, hyaline, and blood casts will be

found on microscopic examination. The diminution in the amount of urine continues for a week at least. The *temperature* is in most cases elevated at night, but it would be misleading to say that it runs any definite course. Some patients suffer from little or no fever. The *pulse* is usually high in tension. It is at first accelerated, but after a time may become extremely slow. If the case is not treated actively from the onset, *œdema* is noticed early. The face, which is from the first pale, becomes swollen and puffy, particularly about the eyelids. The œdema may in serious cases involve the feet, hands, and genitals. Œdema of the glottis is extremely uncommon in hospital-treated patients. Headache may be present, and there is often drowsiness. Should death supervene, it is caused by uræmia, and may be preceded by continuous convulsions or by œdema of the lungs. The vast majority of patients, however, recover completely. The blood and albumin seldom persist for more than six weeks, and the urine is often free of both in little more than a fortnight. Chronic nephritis sometimes occurs in adults, but must be regarded as an unusual sequela.

Another complication of importance is **arthritis**, the so-called "scarlatinal rheumatism," which occurs in about 4 per cent. of cases of the fever. It is more frequent in older children and adolescents, and is most likely to show itself from the sixth to the twelfth day of illness, although in some instances its appearance may be much later. The lesion apparently consists of a slight degree of serous effusion into the joints, and some periarticular swelling. It has been attributed to infection with septic germs, but in all probability depends upon the action of toxins, and may be regarded as analogous to the arthritis which occasionally follows serum injections. The small joints of the wrists and

fingers are most liable to be affected, and this is particularly the case when the complication appears early. The ankles are also very frequently involved. The elbows and knees suffer less, and usually later in convalescence. Any articulation, however, may be affected, and as a general rule several joints are implicated at the same time. The swelling and redness are but slight, and may be absent. The most prominent symptoms are pain and pyrexia. The latter is seldom very considerable, and is of irregular type. The condition is very short-lived, often disappearing entirely in two or three days, and being seldom prolonged for more than a week. Occasionally, however, the pain in the joints may last for a fortnight or longer. Suppuration is unusual, but is sometimes seen in cases of a septic type.

Analogous to the arthritis is the *muscular rheumatism* or myositis which may complicate convalescence, but is comparatively uncommon.

Heart Complications.—These are not very common, but should always be looked for. When *endocarditis* occurs it is usually in conjunction with arthritis, but it may appear alone. *Pericarditis*, which is still more unusual, is most likely to be met with in a septic case. When pyrexia, otherwise unexplained, occurs in the convalescence of scarlet fever, it is always a good rule to remember the possibility of a heart complication.

Adenitis.—As apart from the enlargement of the glands associated with the throat lesions of the fever, and particularly seen in septic cases, a common complication of convalescence is what may be called "late" adenitis. This condition, usually limited to the cervical glands, appears to be quite independent of any lesions in the throat, although it may be due, as has been suggested, to oral sepsis. The glands are moderately

enlarged and tender, and not infrequently go on to suppuration. A considerable degree of pyrexia, usually of a remittent type, is not infrequently present, and often seems out of all proportion to the enlargement of the glands, which may be very trivial. Adenitis may occur at any time during convalescence, but perhaps the most usual period of occurrence is during the third and fourth weeks.

Otitis Media.—This serious complication is extremely common in septic scarlatina, and is also frequently observed in the convalescent stage of an ordinary attack. It may be expected in almost 10 per cent. of the total cases. It usually occurs within three weeks of the onset of the fever, but is not infrequently seen later. Infection of the middle ear often takes place from the throat through the Eustachian tubes, and it should be remembered that syringing the nose of a septic patient may be liable to assist such a process. The inflammation may be catarrhal, in which case the exudation is merely serous, or, as is more usual, purulent. In the latter case the tympanum is soon ruptured and otorrhœa is established. The otitis is not uncommonly double.

The symptoms of commencing otitis are usually considerable pyrexia accompanied by earache. But the latter is by no means invariable, the otorrhœa sometimes appearing with no previous complaint of pain. The glands below the ear may be enlarged. With the establishment of the discharge the pain ceases and the temperature subsides. At first there is some degree of deafness, but this seldom persists. The otorrhœa itself sometimes ceases in a week or a fortnight, but it may last in certain instances for months. Young children are apt to develop mastoid trouble. The signs of a superficial *mastoid abscess* are redness and swelling behind the ear. The auricle is

projected outwards till it is almost at right angles to the head, and there is great tenderness on palpation. The œdema is sometimes considerable above the ear, and may travel forward and involve the eyelids of the affected side. Fluctuation is often evident behind the ear, and on incision pus is found beneath the periosteum.

More serious is the acute suppuration of the mastoid cells which occasionally supervenes. Such symptoms as high temperature, rigors, vomiting, and irritability may call attention to its presence, but the most definite sign is tenderness at the tip of the mastoid process. Still more serious sequelæ are cerebral abscess, thrombosis of the lateral sinus, and permanent damage to the middle ear with total deafness. The latter is certainly unusual; it is, indeed, most uncommon for a patient to leave hospital deaf.

It has been said above that the otorrhœa may persist for months. Nevertheless it usually, even in obstinate cases, ceases within twelve weeks. It is certainly liable to recur in some patients, and may if neglected lead to serious trouble. The discharge is found on bacteriological examination to contain various pyogenic organisms, streptococci, staphylococci, or pneumococci, and very often also diphtheroid bacilli, which need not be regarded seriously, as they are seldom identical with the Klebs-Löffler bacillus.

Rhinitis.—Purulent discharge from the nostrils is often a troublesome complication in the convalescence of scarlet fever. It is most frequently observed in young children, and being infective from patient to patient is liable to spread in hospital wards if suitable precautions are not taken. It is extremely persistent, is apt to recur, and is especially important in that it plays a prominent part in the production of "return cases." It cannot be doubted that the scarlatinal

patient remains infectious as long as his rhinorrhœa continues. The discharge is often of an irritating character, and causes much excoriation in the neighbourhood of the nostrils. It may be expected to occur in about 10 per cent. of hospital-treated cases, including those of the septic type, in which, of course, it is present from the first. The bacteriology is much the same as that of the ear discharge, but true diphtheria bacilli are much more frequently met with.

Other Complications.—Among these may be mentioned *vaginitis*, which in hospital may cause some trouble. In septic cases we have seen that *broncho-pneumonia* not infrequently supervenes. More frequent is septic *tonsillitis*, which is liable to occur in young children in convalescence, and may be followed by glandular enlargement, rhinitis, and all the symptoms of a primary septic attack. *Ulcerative stomatitis* may also occur in convalescence, with swollen and spongy gums and loosening of the teeth. *Cancrum oris* is seen in some septic cases, but more rarely than in measles. Various nervous sequelæ have been described, but their rarity suggests that their appearance in the convalescence of scarlet fever is probably accidental.

Postscarlatinal Diphtheria.—The scarlatinal convalescent appears to have a peculiar susceptibility to diphtheria. The two diseases may and often do run concurrently in the same individual, but, in hospital particularly, it is in convalescence that diphtheria is usually noticed. It may be due either to the patient who develops it being himself a diphtheria "carrier" and becoming infected in his susceptible state by germs which were previously innocuous, or on the other hand to a healthy "carrier" disseminating his infection among other patients in the same ward. No less than 10 per cent. of the scarlet fever patients in

the Edinburgh City Hospital in 1910 were found on admission to be diphtheria "carriers," and such a fact goes far to explain the difficulties encountered in the past by our great fever hospitals. Before the introduction of serum treatment the condition was an extremely fatal one. To-day, if recognized early and treated promptly, it is much less serious.

Diagnosis.—We may have to attempt to recognize scarlet fever at three periods; first in the pre-eruptive, secondly in the eruptive, and thirdly in the desquamative stage. As regards diagnosis before the rash comes out, we must chiefly depend upon characteristic invasion symptoms, an unduly accelerated pulse, and a suggestive appearance. Such a sign as obvious punctation of the soft palate gives great assistance. Nevertheless, unless there is a definite history of exposure, it is wise to await the appearance of the rash before giving a decided opinion. The conditions which are likely at this early period to be mistaken for scarlet fever are diphtheria, a disease in which the invasion symptoms sometimes strongly resemble those of scarlet fever, acute tonsillitis due to various causes, and acute lobar pneumonia, which in young children not infrequently causes initial symptoms of a similar character, and in addition presents a suggestively scarlatinal facies.

In the *period of eruption*, if the rash is characteristic, there should be but little difficulty. The definite presence of sore throat, the history of characteristic initial symptoms, and the appearances presented by the tongue must all be considered. It is well to remember that, although fever is in most cases well marked, it may occasionally be trivial or absent altogether. If the rash is scanty or indefinite, the lower extremities should be carefully examined, as in that situation it may remain fresh and more recognizable. Too much stress should not be laid on a

white strawberry tongue if the other symptoms are indefinite. On the other hand, a typical red strawberry tongue requires very little corroborative evidence to enable a diagnosis of scarlet fever to be made.

In the *period of convalescence* chief reliance must be placed upon the presence of desquamation and the manner in which it corresponds with the history of the case. To find desquamation on the feet of a patient who in the previous week suffered from vomiting and sore throat is no evidence at all, as the foot does not usually begin to peel till the fourth week. On the other hand, typical pinhole desquamation on the neck and chest a week to a fortnight after an attack of sore throat may be regarded as conclusive, and further desquamation in definite sequence may be expected after it (see p. 79). Should a diagnosis require to be made in early convalescence, that is in the first week or ten days of illness, a typical history supported by a denuded raw tongue with papillæ still more or less prominent may be quite sufficient. If, in addition to this, transverse red stained lines are found in the fold of the elbow, or pink papulation is noticed on the rough skin of the legs, the diagnosis should be quite easy. It need hardly be added that the occurrence of typical or suggestive scarlatinal complications, such as nephritis, arthritis, or otorrhœa, in a case presenting unsatisfactory or doubtful desquamation, gives most valuable assistance.

Differential Diagnosis.—After the disappearance of the rash there is often great difficulty in distinguishing scarlet fever from *diphtheria*. In the latter disease the throat is seldom so red, the patches are more difficult to detach, and if detached more likely to leave a bleeding surface behind them, and the tongue does not present the characteristic stages of that of scarlatina. Bacteriological diagnosis is, of course, of great assistance,

but the fact that the two diseases may coexist must never be lost sight of. It is also well to remember that certain cases of diphtheria may present a rash, which, however, is usually too local and too little punctiform to cause serious difficulty.

As apart from diphtheria, the main distinctions to be made are from the eruptive fevers and from adventitious rashes. In other words, the main difficulty is to make certain that a particular rash is that of scarlatina. It is obvious that in the distinctions made below, the history of exposure to scarlet infection, or of characteristic initial symptoms, and the presence of sore throat and suggestive tongue appearances, will go far to establish a diagnosis in favour of scarlet fever. As a general rule *measles* should not present much difficulty. The coryza, the involvement of the face and particularly of the circumoral region, and the condition of the buccal mucous membranes should be sufficient evidence of it. The most common mistakes are to regard the blotchy rash often seen on the extremities in scarlatina for measles, and the confluent rash of measles for scarlet fever. A thorough examination of the patient from head to foot will in most instances settle the diagnosis. The distinction from *rubella* is much more difficult. After the rash of this disease has faded from the face and become diffuse on the body the resemblance to scarlet fever may be very striking. But careful inquiry will often elicit the fact that discrete spotting has been observed on the face on the previous day, and this should be almost sufficient to put scarlatina out of court. Other points of importance are the presence of stiff neck or of unusual glandular enlargement, the polymorphous character of the rubella rash, and the slightly suffused conjunctiva. The scarlatiniform *prodromal rashes* of measles, small-pox, and chickenpox may also give trouble. In the

former case information may be gained by an examination of the mucous membranes, which should show Koplik's spots, and the presence of coryza coupled with the absence of sore throat would also point to measles. In smallpox also the mouth may present characteristic vesicles, and the rash itself is irregularly distributed and seldom punctate. As regards chickenpox, the rash may closely resemble that of scarlatina, but as in the other cases the throat and tongue of scarlet fever are wanting.

Various forms of *erythema*, due to drugs, serum injections, different articles of food, and enemata, must also be considered. Of the *drug rashes*, that due to copaiba is the one most frequently confused with scarlet fever. Its punctation is not very definite and, as is the case with the other drugs to be mentioned, constitutional symptoms are wanting. It may be suspected in young men who present a scarlatinal rash and no typical symptoms of the illness. Of other drugs capable of causing a rash resembling that of scarlatina, we may mention quinine, salicylate of soda, veronal, and other synthetic remedies of the same type, morphia, chloral hydrate, and chrysarobin. Belladonna when pushed causes a uniform brilliant red flush chiefly on the trunk, but this is usually accompanied by marked dilatation of the pupils. In coming to a conclusion in a doubtful case, the possibility of one of these drugs having been used must be considered, especially if the more typical signs of scarlet fever, such as tongue or throat, are missing. Occasionally the symptoms presented by a patient suggest that he is likely to have been treated with a particular drug. The presence of gonorrhœa, for example, can hardly fail to summon the idea of copaiba to the mind of the practitioner.

As regards *serum rashes*, reference may be made to

p. 261. It is sufficient to say here that in hospital it is often very difficult to determine whether a scarlatiniform rash occurring in a diphtheria ward is due to serum or to imported scarlatinal infection. The safest guide is probably the tongue, which in a serum rash will not pass through the characteristic stages. Marked constitutional symptoms would, of course, favour a diagnosis of scarlatina, and this applies equally when *enema rashes* have to be distinguished. These rashes are seldom definitely punctate, and are irregular both in their character and distribution. The face is often a little puffy and blotched. In a doubtful case it is always wise to inquire whether an enema or even a large dose of salts has been administered recently, as in the latter case rashes of a similar nature are occasionally observed. The various forms of *erythema* which follow the ingestion of such articles of food as shell-fish, strawberries, or tomatoes, in particularly susceptible individuals, tend to be somewhat blotchy and to show urticarial patches. While vomiting may precede the appearance of such rashes, the other initial symptoms of scarlatina are absent, and pyrexia is wanting.

Prognosis.—The mortality of scarlet fever varies largely with the type of epidemic. In this country from one to five per cent of the patients succumb. The younger the patient the greater the risk, and infants in particular show a high fatality rate. The death-rate decreases as age advances till fifteen years are reached, after which it rises again very gradually, especially after the age of thirty-five. Toxic cases are practically invariably fatal, and bad signs are a poorly developed or dusky eruption, a very rapid soft pulse, and hyperpyretic levels of temperature. Persistent vomiting or severe diarrhoea in the early stages of the fever should cause great anxiety. The greatest

number of deaths, however, will be found to occur in the septic type of cases, in which if we save as many as three out of four patients we must regard ourselves as very fortunate. In this variety of the illness prognosis must always be guarded, and its gravity is in proportion to the amount of glandular enlargement, to the persistence and extent of the throat lesions, and to the level maintained by the temperature. Broncho-pneumonia adds much to the risk, and restlessness, insomnia or the refusal of food are all grave signs. With the exception of patients who suffer from these severe types of the fever, the prognosis will depend upon the presence or absence of the characteristic *complications*. To take these in detail, nephritis must always be regarded seriously; but if it is treated actively from the first the outlook is good both as regards the recovery of the patient and the future of the kidney. Convulsions and persistent vomiting are perhaps the most serious signs. On the other hand, patients may make an excellent recovery, even if the urine has been reduced to one or two ounces a day for a week or longer. The severity of the case cannot be deduced from the amount of albumin or blood in the urine. Bad symptoms may supervene in cases which present only slight albuminuria, a fact which should never be forgotten. The outlook in cases of arthritis is also good. The condition seldom lasts more than a week or two, and suppuration in the joints is uncommon. Endocarditis, if recognized early and appropriately treated, does not necessarily leave permanent damage behind it. Pericarditis, however, is usually fatal. As long as otorrhœa persists there is always a chance of mastoid trouble occurring. Deafness, on the other hand, seldom follows an uncomplicated case.

Treatment.—The *isolation* of the patient is the first

essential. This can be quite satisfactorily carried out in houses where it is possible to put aside a whole upper flat for the patient and nurse. It is a common custom to cover the doorway with a carbolized sheet, but it is very doubtful if such a precaution is of any practical value except in emphasizing the presence of infection. Relatives must be rigidly excluded, and the medical attendant should wear an overall cloak on his visits. The room, if possible, should be large and well ventilated. Nowadays, however, the vast majority of patients are treated in hospital.

As regards the *management* of the patient, it is a good rule to keep him in bed for three weeks. This carries him past the period at which he is most likely to develop nephritis, and prevents him being exposed to undue changes of temperature. The bedgown should be of flannel, and children who are inclined to sit up in bed may be allowed a light suit of combinations in addition. In dry weather the patient may be allowed out of doors a few days after he has been permitted to leave his bed. This, however, is a hospital privilege, and can but seldom be carried out in private practice for fear of infection. It is wise to cut the hair short in children. Much is lost in any case during the desquamative period. Attention should be paid to the condition of the skin from the first. Daily soap-and-water washing in bed at first, and frequent sponges while the pyrexia continues, are essential. Later, baths may be given at frequent intervals. Inunction with some antiseptic oil, preferably eucalyptus, may be useful in private houses to prevent infected particles of skin contaminating the neighbouring rooms. This carried out systematically in conjunction with the application of carbolic oil (1-10) to the throat for the first few days of the fever has been said to render isolation unnecessary. In the

present state of our knowledge, however, such a view, which was advocated by the late Dr. Milne, must be accepted with extreme caution. The method has not succeeded in the hospitals in which it has been tried.

The patient often requires but little *treatment in the febrile stage*. A mixture containing acetate of ammonia either with sal volatile or nitrous ether may be safely given to improve the action of the skin. If the temperature is high, the nurse can make frequent use of tepid sponges. Should the rash be delayed, scanty, or of a bad colour, hot baths or the application of fomentations of mustard and hot water are advisable. Alcohol is often useful both in supporting the heart and favouring the action of the skin. If the temperature becomes hyperpyretic, the ice cap may be applied to the head. The medical attendant must see that his patient secures an adequate amount of sleep. For adults a dose of bromidia or of veronal is usually effective. For children, if they do not fall asleep after a little hot toddy, which is a good remedy to try first, a moderate dose of bromide of ammonium may be given, or, if preferred, paraldehyde administered by the rectum. During the febrile stage the *diet* will be restricted chiefly to milk, with plenty of water to drink between times. Fruit juices may be used to flavour the drinks, and weak tea may be allowed in moderation. In septic scarlet fever the persistence of the fever may necessitate additions to a pure milk diet, and arrowroot, thin oatmeal gruel, albumin water, Benger's Food, and other similar preparations may be given. If swallowing is very painful and difficult, nasal feeding may be employed with advantage. Alcoholic stimulants are not infrequently necessary. Once the pyrexia has subsided, the patient should remain on light diet during the first few weeks of his convalescence, the object of this being to avoid over-

taxing the kidneys, which are so liable to inflammation. Farinaceous foods, milk puddings, stewed fruit, milk soups, and bread, butter, and jam may be allowed. For drinks, milk should be supplied liberally, and the patient should be encouraged to drink plenty of water. After the third week of illness is over, white fish, chicken, and similar foods can be given, and a little later meat soups, meat, and eggs. In older children and adults, who are much less likely to develop renal complications, the diet may be more liberal and the various additions to it can be made at an earlier date.

Local Treatment.—The throat in mild cases requires but little attention. A simple gargle such as listerine, a dessertspoonful to a tumbler of hot water, or chlorate of potash, is all that is required. In young children the fauces may be swabbed with boroglyceride and glycerine, equal parts. If there is much oedema and pain, nothing gives greater relief than frequent inhalations of steam. The mouth must in all cases be kept scrupulously clean, and the daily use of carbolic acid (1-40) for swabbing the mouth and gums has been recommended as a prophylactic against adenitis, otitis, and rhinorrhoea.

In more severe throats, where there is definite patching or ulceration, chlorine water is an effective gargle. The fauces should be swabbed at frequent intervals with some antiseptic, and all exudation carefully wiped off. Sprays of peroxide of hydrogen are often useful. Frequent irrigations of the throat with hot water from a douche can, held not too high above the level of the patient's head, are also of value in dirty throats. The patient should lie on his stomach, his head projecting over the edge of the bed and supported by the nurse, and the object of the procedure being flushing rather than antisepsis there

is no need to add any antiseptic to the water used. In very filthy cases forcible syringing may be justifiable, but the risk of otitis is much increased by its use. The nose may be sprayed or syringed with perchloride of mercury (1 in 1000), or peroxide of hydrogen.

The throat of a simple case of scarlatina, when treated in hospital, should be looked upon as a clean wound is regarded in a surgical ward. Every care should be taken not to infect it from a septic case, or, indeed, with micro-organisms from any other patient. Frequent and unnecessary treatment increases the risk of such infection, however careful the nurses may be and whatever rules are laid down for the sterilization of throat instruments, crockery, spoons, and the like. Therefore, in clean cases, when the throat symptoms have subsided, there is probably little to be gained by continuing local treatment. On the other hand, in private practice the daily application of antiseptics may lessen the risk of subsequent septic complications, and possibly also shorten the period of infectivity.

Treatment of Severe and Complicated Cases.—

For *toxic scarlatina* little can be done beyond free stimulation with alcohol, and hot packs to induce the skin to act. If vomiting is present, as is often the case, and the patient cannot therefore take fluids by the mouth, saline injections should be frequently given by the rectum, or administered hypodermically. Good results are occasionally obtained by the intravenous injection of normal saline. A hopeful method of treatment is the intramuscular injection of the "whole blood" of a scarlet fever convalescent, the blood being drawn directly from a vein and at once injected. A dose of 50 c.c., or more, may be given. The great advantage of this procedure is that no serum is wasted and no time is lost. The use of antistreptococcic serum has been recommended, but in this type of the

fever there is little justification for its employment. It may, however, be used in *septic scarlatina*, a polyvalent serum giving most chances of success, but it only occasionally influences the condition favourably, and is absolutely useless unless given in large doses (50 c.c. at least), frequently repeated. Vaccines would appear to offer a better chance of success if they are prepared from the patient's own micro-organisms, but the delay in preparation is a disadvantage, and it is impossible to be certain that the causative organism is the one which has been isolated. We are practically reduced to maintaining the patient's strength by suitable diet and stimulation and to active treatment of the throat and nose. If possible, the patient should be put out in the open air for as long as can be managed. The restlessness, irritability, and disinclination for food are all lessened by treatment under open-air conditions. In hospital, septic cases should be isolated and special rules regarding their nursing laid down. In some institutions the nurses attending them wear overall cloaks and rubber gloves, and in this way the possibility of carrying infection is limited. It may be added that by controlling the arms in light poroplastic splints a child may be prevented from infecting the skin of his face by scratching.

The general rules of management already laid down have, it will be noted, the object of, if not actually preventing *complications*, at least putting the patient in the most favourable position for combating them. Thus by keeping the patient in bed for three weeks no exposure which might aggravate a commencing arthritis or nephritis is permitted, and by a judicious dietary all undue strain on the kidneys is avoided. Again, cleanliness of the mouth and teeth may prevent one cause at least of septic conditions affecting the ears, nose, or glands. It is highly important during

convalescence to watch closely for the occurrence of complications and to waste no time before treatment is commenced. And in this connection it is well to remember that the urine should be frequently examined, that is to say every second day at least throughout convalescence and daily during the period at which nephritis is most likely to appear. Should a convalescent vomit, the urine should be examined at once, if a specimen can be obtained. Vomiting is a frequent early sign of nephritis. When *nephritis* is recognized, everything must be done to encourage the skin and bowels to take up the work of the damaged kidneys. The patient should be placed in blankets with several hot bottles round him, and if this is insufficient to secure the action of the skin a hot pack, in a blanket wrung out of very hot water and covered with mackintosh sheeting, should be prescribed and continued for about twenty minutes. A dose of jalap (30–60 grs.) or some other hydragogue should be given at once. The diet must be cut down to milk, with perhaps a little barley water, and water itself may be freely supplied. Treatment on these lines may be continued during the acute stage, while the urine remains scanty. Some patients appear to be benefited by the application of dry or wet cups or leeches to the loins. Should convulsions occur, hot packs may be employed freely, and a few ounces of blood may be taken from the arm. A whiff of chloroform is sometimes useful, or a dose of chloral and bromide may be given per rectum. As the urine increases in quantity, and the blood diminishes, the severity of the dietary may be relaxed. In *arthritis* it is seldom necessary to do more than wrap up the affected joints in cotton wool and place the patient between blankets. Salicylates are very disappointing in this connection, but there is no objection to trying them. Occasionally a very swollen and painful joint is rendered

much more comfortable by the application on lint of oil of wintergreen (salicylate of methyl).

Should the temperature rise in convalescence and there be no very obvious cause for the disturbance, it must be remembered that the heart may be responsible. Again, *adenitis* of a very trifling character sometimes causes a quite disproportionate amount of pyrexia. Enlarged glands are best treated by fomentations of 1-80 carbolic acid. Should suppuration occur, they must be incised. The hard masses of glands which occur in septic cases are best left alone, unless suppuration is very evident. Incisions into them are apt to be accompanied by much sloughing and do little good. Otitis and *otorrhœa* can be treated on ordinary lines. The ear must be kept clean by frequent syringing with boracic acid solution, or still better, peroxide of hydrogen. If there is œdema, even without fluctuation, behind the ear, an incision through the periosteum usually reduces it completely. Should the inflammation involve the mastoid cells, it is well to consult an aural specialist. Removal of tonsils and adenoids will often shorten the duration of a discharge which is tending to become chronic. Vaccines have been used for the same purpose with uncertain results. For *rhinorrhœa* syringing or spraying with various antiseptics may be tried, and it is a good plan to insert a little carbolized vaseline into the nostrils at night. Other complications must be treated on general principles.

Isolation.—A good working rule is to isolate patients for five or six weeks from the date of the first symptom, and only to detain longer those cases in which discharge from the nose, ear, or a suppurating gland exists. A nose should not be regarded as safe if there is any excoriation or scabbing about the nostrils. After a five weeks' detention any skin remaining undesquamated on the soles and heels can

be safely disregarded (see section on "Infectivity," p. 70).

Return Cases.—When a person is brought into hospital with scarlatina from a house to which a convalescent patient has been recently discharged, he is known as a "return case." In the present state of our knowledge of scarlatinal infection such accidents are quite unavoidable, as it seems certain that apparently clean cases can harbour the causative organism in the nose and throat for a long time and, if the circumstances are favourable, transmit it to others. There seems little doubt, however, that an ordinary attack of nasal catarrh can greatly increase the potential infectivity of such cases, and the frequency with which a cold in the head follows a warm disinfecting bath on the morning of the discharge of a patient from hospital has led to a modification of this disinfecting procedure. In many fever hospitals the bath is given the night before dismissal, and the patient is quarantined till morning in a clean ward. It is interesting to note that this alteration in method has led to a prolongation of the average interval which elapses before the "return case" occurs, and at the same time the likelihood of infection is diminished. Other precautions to be taken are the scrupulous isolation of any septic cases in convalescent wards, the separation of convalescent from acute cases in hospital, and care to avoid what may be called intimate contact with susceptible persons after the patient has returned home. For instance, a discharged patient should not occupy the same bed as a susceptible person, should not be indiscriminately kissed by other children, and should, if possible, have cups, spoons, and forks reserved for his exclusive use for a fortnight or more after leaving hospital.

Return cases occur in connection with about 3 per cent. of all scarlatina patients discharged from our

hospitals. In many instances, doubtless, the occurrence of the second case is a pure coincidence, but in the majority the discharged patient is responsible. Return cases often occur after a very long detention in hospital, and we cannot expect to diminish them by prolonging the period of isolation. In a recent series of cases it was found that a group of patients whose minimum detention was four weeks showed an infecting rate of actually 1 per cent. less than that of another group in which the minimum detention was six weeks. It seems almost certain that patients, who may have got rid of their own germs, are liable to pick up those of other convalescents if they are detained too long in hospital.

Prophylaxis.—This depends upon the *notification* of the cases to the Medical Officer of Health, on the *isolation* in hospital or at home of the patient himself, on the *disinfection* of rooms and fomites, and on the *quarantine* of contacts who have not had the disease. A usual period of quarantine is ten days, which gives a very ample margin over the longest possible incubation period, and which in special circumstances might well be shortened to a week. When an outbreak occurs the milk supply should always be investigated and any connection between cases, if possible, traced.

CHAPTER VI.

SMALLPOX.

Etiology.	Complications.
Pathology and Morbid Anatomy.	Types of Smallpox.
The Blood in Smallpox.	Second Attacks. —
Period of Incubation.	Diagnosis.
Stage of Invasion and the Initial Fever.	Prognosis and Mortality.
Stage of Eruption.	Treatment.
The Secondary Fever.	Isolation.
Stage of Convalescence and Desquamation.	Prophylaxis.

Synonym—Variola.

Etiology.—Smallpox, like the other acute fevers, doubtless depends upon infection by a micro-organism. Various bacteria have been cultivated from the pustules of the eruption, but they appear to be pyogenic organisms and merely the result of secondary infection. It appears more probable that the causative germ is of protozoal nature, and recent work points to a sporozoon which is in many particulars analogous to the malarial parasite, and which has been named by Guarnieri the *Cytoryctes Variolæ*. This has been found present in the vesicles both of variola and vaccinia, and in the lesions caused by inoculation of the cornea of rabbits with vaccine and variolous virus. Stages in the life history of the sporozoon have been studied by Councilman and Calkins, and although their work requires further confirmation it is difficult to resist the conclusion

that smallpox is a protozoal rather than a bacterial disease.

Infection and Dissemination.—Smallpox is spread chiefly by *direct infection* from person to person. The infection is present through the whole course of the illness until the last crust has separated from the skin, and is believed to be most active in the stages of pustulation and desiccation. Actual contact with a patient is not necessary to contract infection, it being sufficient to enter a room in which he is lying, especially if ventilation is inadequate. It is probable, then, that the virus is inhaled. It is long-lived, and retains its infectivity for some time in clothing and other *fomites*. Many competent authorities believe that it can be carried for considerable distances by *air*, and that in consequence smallpox hospitals are a source of danger to the surrounding population. It is reasonable also to suppose that the contagion may be carried by insects, such as flies. Lastly, the disease may be transmitted in a somewhat modified form by direct *inoculation*.

As regards conditions predisposing to infection, smallpox may occur in any *climate*, and has been met with all over the world. In this country its *season* is winter and spring, epidemics showing a tendency to abate with the approach of summer. Susceptibility is to some extent affected by *race*, coloured people generally and negroes in particular being especially sensitive to the virus. *Sex* appears to exert no influence, and the same may be said of *age*, it being always understood that this applies to unvaccinated communities. In prevaccination times the chief sufferers, as is the case with measles to-day, were young children. The prevalence of infantile vaccination, however, by affording protection for a considerable number of years, has postponed the age at which persons are

likely to be attacked, and as a result the patients are for the most part adults, except in those cities which are notorious for their contempt of vaccination and which still show an age incidence comparable with that of the days before that means of protection was introduced.

Pathology and Morbid Anatomy.—Smallpox differs from many of the other fevers in presenting two distinct phases, the first of which, the initial fever, appears to depend upon toxæmia, while the second, the eruptive phase, may be regarded as the result of septicæmia, the eruption being due to the deposition in the capillaries of the skin of the causative organisms which have been carried by the blood stream. Much of the inflammation which occurs in and round the pocks subsequently is doubtless due to the action of the pyogenic bacteria commonly found on the skin, which therefore play a considerable part in the production of the secondary fever.

The post-mortem changes are for the most part those observed in all acute fevers. In toxic cases numerous hæmorrhages may be found in the muscles and viscera. The lesions caused by the eruption on the mucous membranes may be seen in the œsophagus, larynx and trachea, and the lungs usually present marked hypostatic congestion and often bronchopneumonia. The heart muscle is degenerated. The spleen is enlarged, soft, and sometimes diffuent. Small focal degenerations may be found in the liver and other organs, and the testicle especially is the site of dense yellowish foci varying in size from that of the head of a pin to that of a pea. Orchitis is relatively common in smallpox, and these lesions of the testicle are said to be a distinctive feature of the disease.

The Blood in Smallpox.—The outstanding feature of the blood changes in smallpox is the relative *increase in the mononuclear elements*. The polymorph cells

seldom exceed 50 per cent. of the whole. Leucocytosis is said to be present during the last few days of the incubative period. With the onset of the fever there is relative or absolute leucopenia. This changes again to a leucocytosis with the appearance of the eruption, but by the time pustulation is reached there is once more a relative leucopenia. The most marked degree of leucocytosis is finally attained in the crusting stage. This alternation in the numbers of the leucocytes is said to be characteristic of smallpox.

Period of Incubation.—This may be put roughly at from ten to fourteen days inclusive. In a large number of cases it appears to last twelve days, and most patients have a period only slightly shorter or longer. The extreme limits reported in rare instances by various observers are from five to sixteen days.

Stage of Invasion and the Initial Fever.—The onset is abrupt, the temperature usually attaining a high level from the first. With the pyrexia the most frequent symptoms of invasion are *headache*, which is usually severe and often accompanied by giddiness, *shivering*, which may be anything from an exaggerated feeling of chilliness to actual rigors, and *vomiting*, which while not occurring as frequently as the other two is met with in more than half the cases, and is particularly common in children. More suggestive still, though it must always be remembered that its presence is far from invariable, is *backache*. This is often extremely severe, and is felt across the loins and sacrum, and sometimes affects the back of the thighs. The patient also suffers from all the symptoms common to toxæmia and high fever, such as insomnia and delirium, and convulsions may occur in children. A common feature of the initial fever is prostration, and the patient always looks obviously ill.

The pyrexia of the initial fever is always considerable, and readings of 104° and over are comparatively common. Rising abruptly and rapidly, the temperature is maintained at a high level till the appearance of the eruption, when it commences to subside. As the eruption is first seen in most instances on the third day of illness, it will be noted that the initial fever is a short one, the normal being usually attained within four days of the first rise. The pulse and respirations are

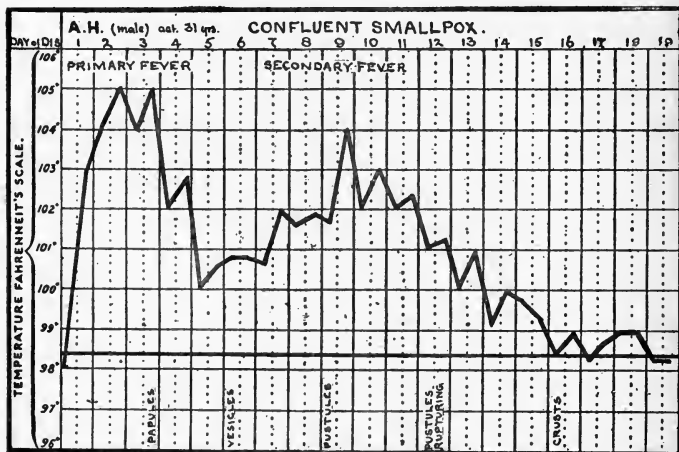


FIG. 8.—Confluent Smallpox in an unvaccinated adult.

accelerated in proportion to the amount of pyrexia present.

Until the eruption appears, then, there is usually little or nothing to distinguish smallpox from other acute fevers. The occurrence, however, of **prodromal rashes** in from 10 to 20 per cent. of the cases gives an opportunity for definite diagnosis in certain instances. These rashes must on no account be confused with the true eruption. They are doubtless due to the toxins of the smallpox organism, whereas it is probable that

the eruption depends more upon the organisms themselves. They may be broadly divided into two classes: (1) erythematous, and (2) petechial. The *erythematous rashes*, again, may be classified according to their appearance as scarlatiniform, morbilliform, or multiform. Their distribution tends to be irregular; they most commonly invade the trunk, are seldom seen on the face, and are apt to be most pronounced in the axillæ and groins. They occur most frequently in adults, usually appearing on the second day of illness, and seldom persist after the true eruption appears. In toxic cases a severe variety of the erythematous type of rash is sometimes present. It is vividly scarlet in colour, and more erysipelatous than scarlatiniform in appearance. The face is usually swollen and puffy, and hæmorrhages appear early on the conjunctivæ and the skin. French writers have termed it the "lobster" rash.

The *petechial rash* is of more importance as being definitely diagnostic of smallpox. It is more commonly seen than are the different varieties of erythema, occurring perhaps in 10 per cent. of all cases. It consists of small punctate petechial spots, either bright red or deep purple in colour, and either scattered discretely or set closely together in a particular area of skin. The spots do not disappear on pressure. They are seen chiefly in two situations, the axilla and the groin, the latter being the most typical site. The arrangement of the rash in the inguinal region is "triangular," the base of the triangle being a line across the abdomen a little below the umbilicus, the apex in the middle line between the thighs a few inches below the pubes. This situation has caused French writers to call it the "bathing-drawers rash." It may be continued into the axilla by a line of petechiæ along the flank, or the axillary rash may exist quite

distinct from that in the groin. When a petechial rash occurs in connection with an erythematous one, the condition may be spoken of as a "mixed rash."

The Stage of Eruption.—After, then, some two or three days of fever, toxæmia, and prostration, sometimes accompanied by one of the prodromal rashes above mentioned, the patient enters on his eruptive stage. His history henceforth, provided the attack is not a hæmorrhagic one, is the history of his eruption and the general symptoms which it causes. In describing the successive stages of the eruption it is convenient to assume that the patient is, like the vast majority of sufferers in this country, an adult who has been vaccinated in infancy and has therefore some degree of protection. In unmodified smallpox the stages last a little longer, and the attack is generally more severe.

The Stage of the Papule.—Dull red macules or spots appear, and are usually first seen on the brow and wrists. They are originally not raised above the skin and disappear on pressure, but in a few hours become distinctly raised, are hard to the touch, and do not disappear when the skin is stretched. The macules, then, have become papules, which are harder, more round and better defined than those of measles. Moreover, unlike those of measles, they do not show the same tendency to coalesce in groups. When palpated, they are in a well-marked case distinctly "shotty." About twenty-four hours after their appearance it is usually possible to see the commencement of vesiculation at the summit of the papules. It is, however, thirty-six or forty-eight hours before the eruption is thoroughly vesicular. During this papular stage the temperature falls, usually attaining the normal with the completion of vesiculation.

Distribution of the Eruption.—Before following the



SMALL-POX, PUSTULAR STAGE.

Note the comparative immunity of the neck and chest.

To face page 112.

[illegible]

papule into the stage of the vesicle it will be well to describe the typical distribution of the smallpox eruption. We have seen that it tends to appear first on the brow and wrists, but other situations are rapidly involved. The eruption is general, but shows a marked preference for certain situations. These appear to be determined to some extent by skin irritation caused by exposure, the friction of garments and so forth, the best protected parts of the body, the axilla for instance, being spared partially or completely. Thus the face, forearms, and wrists show the greatest density of eruption, these parts being most exposed or most affected by free movement. The protected flexor surfaces suffer less than the extensor, and the flank, the most protected region of the body, least of all. The prominences of the face show a more profuse eruption than the hollows. Parts irritated by pressure, such as the waist or the region covered by the garter in women, show a plentiful crop of lesions, and areas of skin which have been recently contused, abraded, or inflamed, as for instance by a mustard leaf, present a much greater density of eruption than the surrounding parts. A comprehension of this peculiar character of the distribution of the pocks is of great value in diagnosis.

Putting aside minor peculiarities, it may be broadly stated that the eruption is centrifugal, that is to say it increases in density the greater the distance from the centre of the body. It tends to be profuse on the head, the face and scalp both suffering markedly. It is much less dense on the neck and upper part of the chest, and is least on the abdomen and flanks. As to the extremities, it is profuse on the hands, wrists, and forearms, and less dense on the upper arms. While, as a rule, the lower extremities suffer less than the upper,

the eruption in that situation is much better marked than on the trunk.

To return again to particular situations, the palms and soles are both involved. Lesions are frequently seen on the eyelids, and more rarely on the conjunctiva. The eruption always attacks the mucous membranes of the mouth, and, developing quickly in that situation, vesicles can be recognized on the soft palate while the skin still presents only papules. The larynx is not infrequently affected, and laryngitis is a common symptom in consequence.

The Stage of the Vesicle.—By the time the papules have become completely vesicular the temperature is, except in severe cases, normal, and the patient feels much better. The vesicle is at first conical. Its contents are fairly clear and translucent. Its margin is rounded, and encircled with a distinct areola of redness. It is firmly set in the skin, and quite hard to the touch in the vast majority of cases. The vesicular stage lasts three or four days, during which the vesicles become larger, more rounded, and more opaque. The size attained may be that of a split pea, and the colour of the contents towards the end of this stage is that of a dull pearl. The vesicle is multi-locular, and does not collapse if a needle is run through it. It tends to show a central depression or *umbilication* caused by its centre being held down by the duct of a sweat gland or hair follicle. This umbilication is by no means invariably present. By the end of the vesicular stage the patient is commencing to feel considerable discomfort, especially if the eruption is profuse, the irritation caused by the increase in size of the pocks embedded in the tough skin of the palms and soles being particularly well marked. The temperature in consequence tends to rise, especially at night.

Stage of the Pustule.—With the change of the character of the contents of the pock into definitely purulent material the eruption enters on the pustular stage. The lesions are now yellowish in colour and continue to increase in size. The areola surrounding them becomes more red and inflamed. The inflammatory process in copious eruptions causes considerable œdema of the skin, which is well seen on the face, which is bloated and puffy. When the pocks are closely set together they may blend into areas of confluence, and the tension in some of them may be sufficient to break up the retinaculum which has divided them into compartments. They may therefore, if pricked or ruptured, discharge the whole of their contents. The development or *maturation* of the pustules is accompanied by considerable pyrexia, the so-called “secondary” fever of smallpox being produced by this process (see Fig. 8, p. 110).

The Stage of the Crust.—By the time the pustule is fully matured, probably four days have elapsed from the time at which it ceased to be vesicular. It is now rounded and tense, with little or no umbilication, and with an inflamed and somewhat indurated areola. On the ninth or tenth day of eruption (that is the eleventh or twelfth of the illness) it may be expected to rupture either from its own tension or as the result of accidental pressure or friction of bedclothes. A thick yellow honey-like material of a disgusting odour is discharged. A crust is formed of a yellowish brown or sometimes almost black colour, and separates in many instances in a few days. If, however, as is often the case, the true skin has been involved in the necrotic process, the crust is deeply set in the skin and may not become detached for weeks. Permanent *pitting* or scarring of the skin is left behind. Owing to many of the pustules set deeply in the

tough skin of the palms and soles failing to rupture, the contents of these pocks gradually dry up into oval brown *disks* which lie under the horny layers of the epidermis and only reach the surface slowly, unless picked out on the point of a penknife.

Classification of Eruptions.—If we omit toxic cases of smallpox, the severity of the illness may be said to depend upon the amount and density of the eruption. It is customary, then, to class cases under three headings, in accordance with the amount of the eruption which they present. Cases in which the pocks are arranged discretely and show no tendency to run together are classed as *discrete*. More severe cases, in which the pocks, while remaining separate from each other, are yet so closely set together as to leave little or no healthy skin visible between them, are termed *coherent* or *semiconfluent*. The worst cases of all, in which the pocks have in certain areas amalgamated and mingled their contents, presenting patches in which the individuality of the lesions is completely lost, are called *confluent*. In classifying a case, however, attention is chiefly paid to the face and forearms, as even in the worst confluent cases the lesions on the trunk may be quite discrete.

The Secondary Fever.—As to the general symptoms presented by the patient during the process of maturation and desiccation of the pustules, they are those which might be expected in a septicæmic condition. *Insomnia* is frequent, especially while maturation is going on, and delirium is not uncommon. Some patients get wildly excited and are difficult to keep in bed. As the illness progresses they tend to become exhausted, and may drift into the *typhoid state*, with low muttering delirium, subsultus, and picking at the bed-clothes. The *pulse* rises with the secondary fever, and in an averagely sharp case will range from 120 to 140

beats per minute. As the fever declines, it not infrequently becomes weak and irregular. The respirations may be much accelerated as the result of laryngeal irritation or pulmonary congestion. The *urine* often contains albumin, and may present the diazo reaction.

The *temperature* is elevated in proportion to the amount of the skin lesions. In very discrete cases the secondary fever may not exist. Usually, however, even in the discrete variety of the eruption, there will be moderate fever for from three to seven days. In coherent and confluent cases the pyrexia is considerable, and a fortnight's fever with temperature readings of 102° to 104° must be expected. The rupturing of the pocks does not terminate the fever, which is doubtless kept up by absorption of septic material from necrotic areas. Desiccation, again, causes much itching and irritation, which also serves to maintain the temperature above normal.

The *appearance* of a patient in the stage of the secondary fever is very characteristic. The face is swollen, the eyelids œdematous, the mouth often held half open as the result of œdema of the buccal mucous membranes, and the expression apathetic. Should the eruption be confluent, the face may appear to be covered by a dirty yellow mask, no normal skin being left visible. Occasionally hæmorrhage occurs into some of the pocks, and gives them a bluish or purple colour.

It has already been noted that even in the vesicular stage considerable irritation in the skin is caused by the eruption. As the pustules mature the patient's sufferings may become intense. The weight of the bedclothes and the pressure of the body on the mattress are often a source of great distress. The stiffness of the hands and fingers, which cannot be moved and are often held partly flexed, is another

cause of discomfort. The mouth, again, may be rendered very uncomfortable by the lesions within it. Some patients have the further misfortune of being acutely conscious of the foetid odour of their own skin. Itching in the crusting stage is often almost unbearable.

When *death* supervenes from toxæmia and exhaustion, it most commonly occurs on the twelfth, thirteenth, or fourteenth day of illness. It may be preceded by hyperpyrexia.

Stage of Convalescence and Desquamation.—When the secondary fever has subsided, the patient enters the stage of convalescence, and unless the attack has been severe regains strength rapidly. He has, however, to be isolated till the last crusts have separated from his skin, and this may be a long and tedious process. While a certain number of the more superficial crusts are early detached, leaving behind them little more than a reddish-brown staining, those which are more deeply set in the skin may not separate for eight or ten weeks. The hair often falls out in large quantities during the desquamative process, and some of the crusts in the scalp are often very persistent. The last to become detached are those which, buried in the thick skin of the palms and soles, slowly work their way through the epidermis, leaving ragged holes in the skin. When these are thoroughly dry, however, they may be picked out with a penknife. Convalescence is not as a rule much interrupted by complications, but glandular swellings and otorrhœa are not uncommon, and boils and small abscesses are often a source of considerable trouble.

Complications.—Of these the most important affect the respiratory system. *Laryngitis*, due to the presence of the eruption on the mucous membranes, may be extremely serious, and œdema of the glottis with almost complete obstruction to the breathing

sometimes occurs. The cartilages of the larynx may also become ulcerated. *Bronchitis* and *broncho-pneumonia* are not infrequently seen, particularly in children.

The eyes often suffer severely. Severe *conjunctivitis* is relatively common. The cornea may also become affected, and ulcers may appear in this situation. Iritis may also occur, and occasionally the anterior chamber is perforated, and destruction of the whole eye results. Otitis, adenitis, and superficial abscesses have already been mentioned in connection with the period of convalescence, at which stage they are most likely to occur. The risk of *bedsores* is perhaps greater in smallpox than in the other acute fevers, as in addition to the profound prostration caused by the disease the inflamed and irritated condition of the skin has to be reckoned with. Occasionally erysipelas intervenes either in the crusting stage or in convalescence.

An interesting complication is *orchitis*. This is seen relatively often during the secondary fever, and the result of post-mortem examinations suggests that, if looked for, it would be found to be present to some extent in a large number of the worst cases. Nephritis sometimes occurs, but is comparatively rare. Various nervous sequelæ of smallpox have been described, such as hemiplegia, and peripheral neuritis is occasionally the cause of some degree of paralysis.

Smallpox occurring in *pregnancy* is very liable to cause abortion, which may be said to be inevitable in the confluent forms of the disease. In more moderate attacks abortion takes place in about one-third of the cases, and the more advanced the pregnancy the greater are the probabilities of the accident occurring. As regards the fœtus, it as a rule escapes taking smallpox, but it may be born with the eruption, or may on the other hand develop smallpox shortly after birth, having contracted the disease *in utero*.

Epidemic Types of Smallpox.—It is now generally recognized that there are two main epidemic types—a severe one, spoken of as the eastern or African type, and one of much milder character, the American type. Subvarieties of the eastern type have been recognized. Two conditions which appear to be aberrant varieties of smallpox are also described, *amaas* or Kaffir milkpox and *alastrim*. They are chiefly remarkable for the mildness of their symptoms and for the tendency of the eruption to appear in crops.

Clinical Types of Smallpox.—As in other fevers, these may be classed as mild or severe. Of the mild types it may be said that they depend either on scantiness of eruption, as in very discrete smallpox, or on modification of type, as in the condition usually spoken of as **varioid**. This term has been used to comprise all cases of smallpox which occur in the vaccinated, and present the slightest modification. It may well, however, be reserved for the very slight or abortive cases which show marked deviations from the normal stages of the development of the eruption. It must be remembered that, while the term suggests that the condition described is merely “like smallpox,” in reality these cases are true smallpox, often highly modified, it is true, but still capable of communicating the disease in its most severe form to others. Being difficult to recognize, they are responsible for much spreading of infection.

In these mild cases the initial symptoms are often quite severe and the fever high. The eruption, however, tends to come out early rather than late, and is usually extremely scanty. Only a few lesions may be discovered on the whole surface of the body, and these may either develop normally or abort. In certain cases, termed *variola sine eruptione*, no eruption appears at all. In another type of varioid the

Figure 1 shows a 3D plot of 1000 random vectors. The vectors are represented as small black arrows originating from a central point. They are distributed uniformly in all directions, forming a spherical cloud. The axes are labeled with numerical values, indicating the 3D coordinate system.

PLATE IV.



CONFLUENT SMALL-POX.

To face page 121.

eruption is reasonably profuse, but its elements do not develop in the normal manner, papules, for instance, remaining papules, or vesicles drying up before they become pustular. Sometimes, again, vesicles may be found which are monocular and collapse readily on pricking. A few lesions will usually run through all the typical stages, but, being surrounded by others which show different phases of abortion, they yet leave the diagnosis extremely difficult.

While confluent cases are very severe and often fatal, they present what is merely an exaggeration of the ordinary type of the disease. The really severe type is the **toxic**, in which the patient succumbs to the toxins of the initial fever before the true eruption has properly developed. The outstanding feature of this type is the occurrence of hæmorrhage into the skin and from the mucous membranes. Sub-varieties have been described, but except as regards virulence there is really no difference in type. In the worst cases the initial symptoms are very severe and the temperature high. The face tends to be pale, and the expression is anxious. Prodromal rashes may be present, either petechial or erythematous, and a vivid red erythema turning to a terra-cotta colour is sometimes observed. On the second or third day numerous hæmorrhages appear on the skin, particularly in the groins and axillæ, but also scattered over the whole body. They vary in colour from pale purple to black. Subconjunctival hæmorrhages are common, as is epistaxis. Much blood is passed in the stools. The urine is scanty and contains large quantities of blood; hæmatemesis and hæmoptysis are both liable to occur, and blood oozes from the gums. Thirst is a prominent symptom.

With the first appearance of the hæmorrhages the temperature tends to fall, and on the third and fourth

days may only average about 100°, rising again just before the fatal termination. The pulse is rapid, soft, and compressible. Death may occur as early as the third day, but is sometimes delayed till the seventh or later. If the patient survives long enough, the eruption attempts to come out, but the vesicles develop badly, being flat and empty, and owing to hæmorrhage beneath them may have a pale blue colour. Delirium is present in some cases, but often the mind is clear and the patient acutely conscious to the end.

Should the eruption appear, it will be seen that the hæmorrhages are, broadly speaking, quite distinct from the elements of the true eruption, tending to lie between them rather than in them, though hæmorrhage into the base of the pocks is not at all unusual. A true hæmorrhagic or toxic case must not be confused with a severe case of ordinary smallpox which happens to present pocks which contain blood owing to bleeding having occurred into them. Such cases may recover completely, whereas the real toxic variety is always fatal.

Second Attacks.—It is unusual for a person who has had smallpox once to suffer from it a second time. Such attacks, however, though exceptional, do occasionally occur. The immunity resulting from a first attack is very much stronger and more long-lived than that conferred by vaccination. The second attack, when it does occur, is usually mild.

Diagnosis.—The diagnosis of smallpox naturally falls under two headings. First, we have to recognize the disease in the stage of the initial fever. Secondly, we have to differentiate the eruption, when it appears, from the conditions liable to resemble it.

The *diagnosis of the initial fever* may be difficult, or indeed impossible, if we have not the history of a definite exposure to the infection to assist us. In that

case, of course, the sudden onset of acute fever, with chills, headache, vomiting, and pain in the back, would be ample warrant for provisionally isolating a case. It is unlikely, indeed, at this stage that we can do more than suspect the existence of smallpox unless a prodromal petechial eruption is present. Should, however, the triangular rash be present in the groins, the diagnosis is made. It must be recollected, in considering the symptoms presented by a case, that backache, though a highly suggestive sign, especially if severe, is not infrequently wanting, and its absence, therefore, is no argument against a case being smallpox.

In coming to a conclusion, we may have to distinguish the initial fever from influenza, a fever which also presents high fever, severe headache, and often marked backache in its early stages.

If erythematous prodromal rashes appear, the diagnosis is rendered still more difficult. A scarlatiniform rash may suggest scarlet fever. As a rule, however, the rash of smallpox is not definitely punctate and is more irregularly distributed than that of scarlet fever. Sore throat, moreover, is not complained of, and the tongue though furred shows no special prominence of the papillæ. A morbilliform rash may give rise to a suspicion of measles, but as a rule it is macular rather than papular, and the absence of a history of prodromal catarrh and the want of Koplik's spots and other characteristic appearances of the buccal mucous membrane should be sufficient to dismiss this possibility. Measles, again, seldom presents a sudden onset, with such symptoms as shivering, backache, and vomiting, which are all common in the more severe disease.

In all cases where smallpox is suspected and the eruption is being waited for, the examination of the

soft palate for early traces of it is advisable. Vesicles often are recognizable in this situation as soon as the first macules commence to appear.

The *diagnosis of the smallpox eruption* resolves itself into its differentiation from measles, chickenpox, and various pustular conditions which resemble it. To take *measles* first, smallpox resembles it in the papular stage of the true eruption, but the difficulty can only last till the stage of vesiculation. The history of the prodromal symptoms will be of assistance in making this distinction, taken together with the distribution and arrangement of the papular rash and the character of its individual lesions. The mouth should be examined, as it may present either Koplik's spots in the one case or definite vesicles on the palate in the other. The complete absence of coryza would be a strong point against measles. As to the papules themselves, those of measles are softer and less definitely elevated than those of smallpox, but it must be remembered that occasionally the measles papules are relatively hard to the touch on the brow. The measles rash is evenly distributed all over the face and body. That of smallpox follows the general distribution indicated on a previous page (see p. 112), and tends to be much more dense in some situations than in others. The individual lesions, moreover, at this stage show far less tendency to coalesce into irregularly shaped blotches than is the case in measles. Lastly, the temperature, which rises or remains high with the development of the measles eruption, gradually subsides during the papular stage of smallpox.

The diagnosis from *chickenpox* is much more delicate, and in this case the difficulty may be prolonged. Two points should never be forgotten: first, that adults not infrequently suffer from chickenpox; and second, that, although prodromal fever is unusual in chicken-

pox, it nevertheless does occur in some instances, and especially in adult cases.

While allowance must be made for the point last named, the first distinction between the two diseases is undoubtedly the fact that in chickenpox the eruption is usually the first indication of the disease, and that, if there is fever, it is more liable to increase with the development of the lesions, and not to precede their appearance.

Chief weight, however, must be laid upon the distribution of the two eruptions. That of smallpox has been already described and its centrifugal character noted. That of chickenpox, if anything, is centripetal, that is to say it will be found in greatest profusion on the back and trunk, to a lesser degree on the face, and least of all on the extremities, especially the forearms and hands. Should it occur in the latter situation, as may well happen in a very severe case, its density is no greater than on the upper arm or trunk, and is probably much less. Another point of importance is that chickenpox lesions are often quite numerous in the flank and axilla, situations which smallpox tends to spare. The spots, moreover, do not show any special preference for exposed or prominent regions of skin, as is the case with those of smallpox.

The first spots of chickenpox are usually seen on the trunk. In smallpox the face and wrists show the earliest papules.

The appearance of the individual lesions of the two eruptions differs considerably. The oval-shaped, thin-walled, superficially lying vesicle of chickenpox is quite unlike the more rounded, firmer, and deeply set vesicle of smallpox. It is true that the chickenpox lesions may present all sorts of different appearances, but the presence of one or two absolutely typical ones is sufficient to make a diagnosis. If pricked, the

chickenpox vesicle collapses readily. Umbilication, properly so called, is not met with in chickenpox, but it may be imitated by the partial escape of the contents of the vesicle, and the scabbing over of the small central orifice through which the fluid has escaped. Any increase in the amount of fluid remaining causes the vesicle to swell up round a small central depression, and a condition resembling umbilication results. Many chickenpox vesicles show puckering or crenation at their edges, and this sign, not observed in smallpox, is often helpful. In the later stages of the eruption the crusts of chickenpox are usually more oval and much less deeply set in the skin than those of smallpox.

It must also be remembered that in chickenpox the vesicles continue to come out for several days, and pass through their various stages independently of each other. As a result lesions in all stages may be seen in the same area of skin, a vesicle sometimes lying beside a crust. In smallpox the eruption comes out once and for all, and its elements develop synchronously. In a given area of skin, then, all the lesions are in the same stage. In varioloid, however, this difference in the state of development of the pocks is sometimes observed.

The condition of the patient as regards vaccination may in certain circumstances give some assistance. In a patient of under ten years presenting good vaccination marks the presumption is all in favour of chickenpox, and the younger the patient the stronger this presumption becomes.

The above-mentioned are probably the chief distinctions between the two diseases. In weighing the evidence most stress must be laid on the distribution of the eruption. It is unfortunately the case that patients suffering from varioloid may present lesions which are not by any means typical of smallpox, and

in them many characteristic signs may be wanting. But even so the distribution will be usually of the smallpox type. It may be added that the chickenpox patient seldom looks ill. If the eruption is at all profuse, an alert expression and an absence of prostration are much against the case being one of smallpox.

Various vesicular and *pustular eruptions* may be confused with smallpox. We need only mention acne, which presents no constitutional symptoms and occurs chiefly on the face and shoulders, the drug eruptions caused by bromides and iodides, and pustular syphilides. The distribution of the suspected eruption, the history and circumstances of the case, and the appearance of the individual lesions will in most instances decide the diagnosis.

The toxic variety of smallpox has to be distinguished from purpura hæmorrhagica which may also begin with headache, vomiting, and high pyrexia.

Vaccination may be used as a final test in diagnosis. When performed in the incubation period it is often successful, though the proportion of successes gets smaller as the inoculation is made later. It may even succeed on the first day of the eruption, but if it is successful when performed on the second day of the eruption it may be held as proved that the illness is not smallpox.

Prognosis and Mortality.—Prognosis is always much affected by the condition of the patient as regards *vaccination*. The more recent the vaccination or the revaccination, the better the chances of the patient. A revaccinated person, indeed, rarely takes smallpox, and the case mortality of those vaccinated in infancy is very much lower than those who have not been so protected. The number of marks and their superficial extent is of some importance, as is also their condition as regards foveation (see chapter on Vaccinia). It

must be understood, however, that trivial attacks of smallpox can and do occur in unvaccinated subjects.

In the vaccinated, then, the younger the patient the less is the probability of a severe attack. Among the unvaccinated, on the other hand, in whom the natural effects of *age* can be better studied, it is found that infants and children in the first five years of life show the highest case mortality, the rate probably exceeding 40 per cent. The next five years of life are much less fatal, and thereafter mortality rises with advancing age, and in persons of over forty may even exceed that of young children. *Sex* does not exert any appreciable influence.

A trivial initial fever means that the attack will be also a mild one. The converse, however, does not hold, as a severe initial fever may be followed in some instances by a slight attack of varioloid. A very brilliant scarlatinal prodromal rash not infrequently appears in toxic cases. Petechial groin rashes sometimes precede even slight attacks. Nevertheless they occur most frequently in confluent or severe discrete cases. Very intense pain in the back is often associated with the toxic type of the disease. The appearance of purpuric hæmorrhages on the surface of the skin may be regarded as a fatal sign.

An imperfect remission of the pyrexia between the initial and secondary fevers usually denotes a more than averagely severe case, and conversely a low or normal temperature during the vesicular stage is of favourable import. Cases are usually severe in proportion to the amount of the *eruption*. In some cases of varioloid, however, the eruption may be very profuse and yet many of its elements abort, the secondary fever being trivial or absent. A rapid development of the lesions, each stage being short, is seen in highly modified cases, and is therefore favourable to the

chances of recovery. The case mortality of confluent cases in the unvaccinated is not less than 60 per cent. In the vaccinated, though still very serious, they are not so fatal. Discrete cases usually recover.

During the *secondary fever* such symptoms as high temperature, a pulse of over 120, and marked delirium and nervous symptoms should cause anxiety. Rapid respiration, suggesting hypostatic congestion or a complicating broncho-pneumonia, is also a bad sign. Œdema of the glottis is most dangerous.

Hæmorrhagic or *toxic* cases may be regarded as invariably fatal. A little bleeding into some of the pocks, however, need cause no particular alarm.

Treatment.—The indications are, firstly, to maintain the strength of the patient by suitable diet and medication, and secondly to attend to the local skin condition with the view of modifying as far as possible its development and preventing subsequent disfigurement.

General Management and Treatment.—The patient should be placed in airy surroundings, and the allowance of cubic feet per bed in hospital should not be under 2000. The wards should not be too light. In the initial fever the *diet* is best limited to milk; it may be increased considerably in the vesicular stage if the temperature has come down; and it should be restricted to fluids, and soft solids if they are taken well, during the secondary fever.

The initial headache is best treated by the application of ice to the head. Hot applications sometimes relieve the backache. Insomnia should always be treated, and many cases do well with a mixture of chloral and bromide, or a dose of sulphonal or veronal may be given. If the fever is high, cold sponges may be used frequently.

When the eruption has developed, hoarseness and laryngitis are best treated by steam inhalations.

Sleeplessness at this stage is often due merely to skin irritation, and a 5-gr. Dover's powder is sometimes enough to secure sleep. Stimulation with alcohol is not infrequently necessary in bad cases, and strychnine is occasionally of value, especially when the breathing becomes laboured owing to hypostatic congestion of the lungs. Excited delirium is best controlled by hypodermic injections of morphia or hyoscine. In patients with profuse and painful eruptions a water bed sometimes gives relief and helps to avoid bedsores, and it is always a good plan to have the covering bedclothes supported on a cradle to avoid pressure and friction. When the smell is very offensive, creasote, or some similar substance, may be vaporized at the bedside over a spirit lamp.

The *toilet of the mouth and eyes* is of the greatest importance both for the comfort of the patient and the preservation of his sight. The mouth should be thoroughly cleaned every four hours, if necessary, and swabbed with an ointment of boracic acid in vaseline, or with boroglyceride. Gargling should be encouraged. In painful deglutition a spray of cocaine before feeding is a useful measure. The eyes should be bathed frequently with boracic or weak corrosive solution. The lids should be smeared with vaseline, and care taken to prevent them becoming glued together. If the cornea becomes affected, an ointment of yellow oxide of mercury with atropine may be useful.

In *toxic* cases no treatment is of any avail, and hæmostatic drugs completely fail to check the hæmorrhages.

Local Treatment.—In an average case of smallpox the condition of the skin is the chief cause of distress to the patient, and is also responsible for much fever and septicæmia. Local treatment is therefore perhaps of even more importance than general treatment.

Elaborate ointments have been suggested, but simple methods are equally or more efficacious. Of these may be mentioned the application to the face of a light mask of lint, frequently soaked in iced water and kept thoroughly moist. For patients who will not tolerate even a mask, the smearing of the face with carbolized vaseline is useful. When the pocks have commenced to rupture and the odour is offensive, a little iodoform may be added to the vaseline. Later, when the crusts have separated, raw surfaces can be treated with zinc ointment.

During the stage of desiccation, when itching is very troublesome, warm baths probably give greater relief than any other form of treatment. Baths indeed may be employed with advantage, through the whole attack, for patients able to take them. They may be repeated several times a day, and besides allaying skin irritation have the advantage of hastening the separation of the crusts. This may also be accelerated by the use of linseed poultices sprinkled with iodoform, or simple starch poultices.

Various attempts have been made to abort the eruption. Of drugs used for this purpose salol is the only one which need be mentioned, and its value is somewhat doubtful. It is, however, worth trying in patients who come under observation early, that is not later than the papular stage. A suitable dose is 10 grs. four-hourly. This treatment causes no bad effects and may possibly modify pustulation.

More recommended but difficult to carry out properly is the treatment by *red light* introduced by Finsen. This treatment depends on the absolute exclusion of actinic rays, and practically means treating the patient in a photographic dark room. Red glass for the windows and red shades for the lamps are required. It is no use expecting results if the treatment is started

after the fourth day of illness, that is to say the patient must be placed in a dark room while he is yet in the early papular stage. It is claimed that in such cases the eruption aborts and does not become pustular, but this has been denied by competent authorities. In any case, the difficulties of carrying out such a method, and the comparatively small number of patients who come early enough under observation to give it a fair chance of success, will always limit its usefulness.

Treatment of Convalescence and Complications.—In hospital, after the fever has subsided, the patient may be allowed out of bed and, when his strength permits, into the open air. He should be liberally fed, and if the attack has been a severe one port wine or stout may be prescribed with advantage. Frequent baths should be given.

Complications must be treated on the usual lines. The small boils and abscesses which so frequently complicate convalescence should be freely opened. Their appearance is an indication for some general tonic such as quinine. Should orchitis occur during the fever it should be treated with fomentations of lead and opium, and the parts adequately supported.

Isolation.—The smallpox patient must be detained till the last crust separates from the skin. This in mild cases may be within three weeks; in severe, sometimes many months. From six to ten weeks is a very ordinary period of detention.

Prophylaxis.—The control of an epidemic of smallpox depends first on the *isolation* in hospital of all affected persons, and secondly on the prompt *vaccination* of all contacts. Quarantine may be used for those who refuse vaccination, or who can only be kept under efficient supervision in a reception-house. Disinfection of infected houses is essential. Old wall-paper should be removed and the walls thoroughly cleaned. All

bedding and other fomites must be disinfected with steam. A useful measure is the compulsory notification of chickenpox cases, as smallpox has not infrequently escaped isolation by being considered to be the less serious disease. A Medical Officer of Health with the information which he has at his disposal is sometimes able to correct such errors in diagnosis.

CHAPTER VII.

VACCINIA.

Acquired Immunity from Smallpox.	Nature of Vaccinia.
Variolation.	Vaccine Lymph and Vaccination.
Cowpox.	Value of Vaccination.
Vaccinia in Man.	The Case against Vaccination.
Generalized Vaccinia.	Conclusions.
Accidental Vaccinia.	

Acquired Immunity from Smallpox. — Protection against smallpox may be obtained in one of three ways. Firstly, an attack of the disease itself will usually confer immunity against subsequent attacks. Secondly, variolation, or in other words inoculated smallpox, secures a degree of protection only slightly inferior to that conferred by an actual attack. Thirdly, vaccination, or the inoculation of cowpox, gives, if practised sufficiently often, complete protection against the disease.

Variolation. — The interest of this is purely historical, as its practice in this country has been very properly forbidden by law. It had, however, its advantages in the days before vaccination was introduced, as it secured a comparatively mild and adequately protective attack of a disease which was regarded as inevitable. The inoculation was made with a lancet into the skin of the upper arm, and care was taken to use only the clear lymph from the smallpox vesicle, and preferably from that of the inoculated disease. About four days later there was a local reaction, and papules appeared

at the site of inoculation. The pocks became pustular about the seventh day. The patient suffered from considerable fever, and subsidiary pustules appeared in the areola round the point of inoculation. By about the eleventh day the temperature fell, and a generalized smallpox eruption appeared on the other parts of the body and ran a fairly normal, if somewhat rapid, course. This eruption was almost always discrete, and apparently of the type of what we should now term "varioid." Occasionally, however, it was severe and accompanied by secondary fever, and in a small proportion of cases death resulted. The obvious disadvantages of the procedure as a protective measure were first the possibility of a fatal issue, and second the fact that, like varioid, inoculated smallpox is capable of transmitting the disease in its most severe form to unprotected persons. The practice, then, was liable to spread infection, and that possibly of a serious type.

Cowpox.—This is an eruptive disease of the udder and teats of cows. Vesicles appear on the teats and, rupturing, leave irregularly shaped ulcers. These may infect any abrasion on the hands of the milker, and what is called *casual cowpox* results. Large circular vesicles with a concave surface form on the hands, especially about the joints and tips of the fingers. The surrounding parts become inflamed and indurated and the axillary glands enlarged. The symptoms are more severe than those of ordinary vaccination, and fever is usual. The vesicles either ulcerate or dry up. There is no general eruption, and the condition is not a fatal one. Similar to the condition which affects the cow is what is known as "grease," or horsepox, which occurs in horses.

Vaccinia in Man.—After inoculation with vaccine lymph, there may be some irritation at the site of the abrasions for twenty-four hours. After an incubation

period of three days, raised red somewhat flat papules appear at the site of scarification, and by the fifth day show distinct vesiculation. The vesicles contain clear lymph and are surrounded by an areola of redness. They reach their full development on the eighth day after inoculation, and are usually plump and well filled at the edges and slightly depressed in the centre. For the next two days maturation of the pock proceeds, the contents becoming cloudy and ultimately purulent. There is now as a rule distinct inflammation of the surrounding skin. This inflamed area stands up above the skin level, but its edges are not well defined. If the whole arm swells up, it is more than probable that sepsis has occurred. From the tenth day onward desiccation sets in, the vesicle, whether ruptured or unruptured, drying up and forming a crust. The scab is set deep in the skin and is firmly adherent. From two to three weeks from the date of vaccination it separates, leaving behind it a pinkish scar which gradually becomes white, and presents a well-marked pitted surface, or *foveation*.

During the process of maturation there may be *general symptoms*, which are usually slight. Headache, malaise, and loss of appetite are commonly observed, and children often sleep badly and sometimes vomit. If the symptoms are very severe, sepsis should be suspected. Some patients suffer from slight initial fever about four days after inoculation, and children at this period may have erythematous rashes.

Generalized Vaccinia.—In some cases, in addition to the pocks on the arm, vesicles appear in other situations. These are often the result of scratching and auto-inoculation. Such transmitted lesions develop very rapidly, and soon reach the same stage as the original vesicles. More rarely a generalized papular

eruption follows vaccination, usually appearing between the fourth and tenth days. The eruption comes out in crops, and as each individual lesion passes through vesicular and pustular stages all stages of development may be visible in the same patient at the same moment. Some fever is present. The cause of this generalization of the vaccinia is unknown. Fortunately it is very seldom met with.

Accidental Vaccinia.—By this we understand cases in which a mother or other attendant on a recently vaccinated child accidentally inoculates herself from its pocks. The resulting vaccination may be observed in any situation, but is usually on some part of the face, the nose and eyelids being not unusual situations, owing to the tendency to scratch them.

The Nature of Vaccinia.—It may be presumed that the relationship of vaccinia to smallpox is a very close one. Its identity with smallpox has been difficult to prove. Experiments have often been made with a view of inoculating bovine animals from smallpox patients, and Copeman has succeeded in producing vaccine vesicles in calves, using lymph obtained from monkeys which were inoculated from smallpox vesicles. We may accept his deduction that vaccinia is nothing more nor less than smallpox modified by transmission through the bovine animal. It is only right to add, however, that certain French experiments have failed to reproduce his results.

Another argument in favour of this theory is a histological one. Councilman found that the results of the inoculation of smallpox and vaccine lymph on the cornea of the calf and rabbit are identical.

Vaccine Lymph and Vaccination.—For a long time arm-to-arm vaccination was practised, but this had distinct disadvantages, as the possibility of the transmission of disease from one child to another had

always to be considered. Since 1899 the use of glycerinated calf lymph has been practically universal. The glycerine destroys any saprophytic organisms in the lymph, and does not itself interfere with the efficacy of vaccination. The calves used to supply the lymph are tested with tuberculin. The skin of the abdomen is shaved, and inoculations of glycerinated lymph are made with all aseptic precautions. Ninety-six hours later the epithelium and underlying vesicular pulp are removed with a sharp spoon, and the scrapings are ground up in a mortar with four times their weight of a sterilized 50 per cent. mixture of pure glycerine and distilled water. The resulting emulsion is stored in a cool, dark place, and is ultimately drawn up into sterilized capillary tubes for distribution.

In performing vaccination, it should be remembered, the same care should be exercised as in any minor surgical operation. Precautions must be taken to secure asepsis, both by cleansing the skin of the patient and by sterilizing whatever instrument is employed. It is neglect of these elementary precautions which has done so much to make unpopular a practice which, properly performed, is extremely unlikely either to cause undue inflammation in the arm or to be followed by undesirable sequelæ.

The scarification may be done with a needle, a blunt lancet, or one of the scratching instruments devised for the purpose. The arm should be first washed with soap and water, and then with some weak antiseptic lotion which can be washed off with plenty of sterilized water. The scarifications can be made through a drop of calf lymph lying on the skin. The scratches should not draw blood, but should be deep enough to show a little pink. They should not be made across each other, but all in the same direction. Otherwise there is unnecessary loss of tissue from the

necrosis of small areas of skin, and an ugly deep scar results. In a primary vaccination it is advisable to make four marks. These should not be too close to each other, and should be made in the neighbourhood of the insertion of the deltoid muscle. If for any reason a smaller number of marks is made, they should be proportionately larger in size, the amount of protection conferred being influenced by the superficial extent of the scars. After vaccination great care must be taken to keep the arm clean. Shields should not be encouraged, but a plain pad of antiseptic wool may be applied to the arm, and some simple dusting powder, such as boracic and starch, may be used to keep the pocks dry. It is much easier to keep the wound satisfactorily clean if rupture of the pocks is avoided.

The law demands that vaccination be performed within six months of the birth of a child. Unfortunately, however, any one who professes a conscientious objection to it, on the ground that it would be prejudicial to the health of his child, can obtain exemption by making a declaration to that effect. The process of exemption has become so easy that there is now an annually increasing vaccination default.

The Value of Vaccination.—It was apparently known before the time of Jenner that cowpox gave some degree of protection against smallpox. But to Jenner the whole credit of the discovery must be given, for it was he who first scientifically studied the question and who brought the results of his experience before the public. He was enabled to prove that vaccination protected against inoculated smallpox, the practice of variolation, widely used in his time, giving him the opportunity of performing experiments which would rightly be disallowed to-day. His first paper was

published in 1798. He did not, however, realize that the protection conferred by vaccination is only temporary, and that to secure complete immunity to smallpox revaccination at intervals is required.

The student should have an intelligent comprehension of the evidence on which our belief in the value of vaccination and revaccination is founded. He should be able to explain the necessity for their universal practice to his patients, and by studying anti-vaccinationist literature should make himself reasonably familiar with the arguments of the opposition. While it is impossible with the space at our disposal to enter into elaborate statistical details, stress may be laid on the following points:—

(1) There is a marked *fall in mortality* from smallpox dating from the introduction of vaccination. This has been noticed everywhere where comparative returns of the number of smallpox deaths are available.

(2) Vaccinated persons suffer from smallpox in a much smaller proportion than do the unvaccinated. At a time, for instance, when only 10 per cent. of the children of London were unvaccinated no less than 46 per cent. of the total number of children under ten years admitted to the smallpox hospitals were found to be unvaccinated. The unvaccinated population, therefore, yielded for its numbers nearly five times as many cases of smallpox as the vaccinated. It has also been shown in recent outbreaks that at all ages, but among children especially, the vaccinated population of invaded houses had a much lower *attack rate* than the unvaccinated. Thus at Warrington only 4·4 per cent. of the vaccinated children exposed were attacked as against 54·5 per cent. of the unvaccinated.

(3) Since the introduction of vaccination in infancy

the *age incidence* of smallpox has entirely changed. Formerly the disease resembled measles. Nearly every one took it in early life, although it was liable to attack any older person who was not protected. To-day, owing to the immunity conferred for the earlier years of life by the infantile vaccination, the vast majority of smallpox patients are adults, persons in other words who have exhausted their immunity. That the disease itself has not altered in its possibilities is demonstrated by the fact that in anti-vaccination centres the age incidence is that of the prevaccination period. During the last epidemic in Gloucester, a town notorious for its neglect of vaccination, 64 per cent. of the patients were children under ten years of age, whereas in Glasgow, at that time well vaccinated, 5·5 per cent. only were under ten years, and of these two-thirds were unvaccinated.

(4) As regards *the mortality of persons attacked*, there is a great difference in favour of the vaccinated. In the Glasgow epidemic of 1901-2 the mortality was 10·4 per cent. among the vaccinated, and 51·6 among the unvaccinated. Again, persons presenting numerous or well-foveated marks show a lower death-rate than those who have fewer or less well-defined marks. Four marks give greater protection than three, three than two, and two than one. As regards the superficial area of the scars, M'Combie found that, if one-third of a square inch of well-foveated surface be held to constitute efficient vaccination, of 1435 patients showing efficient vaccination 2·5 per cent. died, whereas of 4375 patients showing imperfect vaccination 8·7 per cent. died.

In the same way it is found that severe types of smallpox, such as hæmorrhagic and confluent, occur much more frequently in the unvaccinated, while a very large percentage of the cases which occur in the vaccinated are either varioloid or discrete.

(5) Systematic *revaccination*, affording as it does complete protection, gives the most striking proof of the value of vaccination properly used. In Germany, where the law insists on revaccination at school age and where the male adult population is again re-vaccinated on entering the army, it is not found necessary to maintain smallpox hospitals. The disease is frequently imported from Russia, which is a badly vaccinated country, and when outbreaks occur almost half of those who take it are foreigners. Smallpox hospital attendants in this country are usually revaccinated. The Vaccination Committee of the Epidemiological Society found that of 734 attendants employed in hospitals of the Metropolitan Asylums Board, 79 had had smallpox, and 645 had been successfully revaccinated before undertaking duty. None of these took the disease. The remaining ten had not been revaccinated, and all contracted smallpox. The only Edinburgh City Hospital nurse who contracted smallpox in the last forty years was also the only nurse who refused revaccination in that time.

The Case against Vaccination.—The anti-vaccinationists can only meet these arguments by denying the facts. They allege that vaccination does not protect against smallpox and that the figures given by reputable medical authorities regarding the condition of their patients as to vaccination are unreliable. They suggest, for instance, that in very bad cases of smallpox a profuse eruption hides the marks, and that fatal cases are therefore frequently classed as “unvaccinated.” This is not at all likely, as in the most fatal type of smallpox, the toxic or hæmorrhagic, there is nothing to obscure the marks if they are present, and even in the most confluent cases the upper arm, the site of the marks, seldom has such a dense eruption that the

marks would be missed. But even if such a possibility were granted, this would not affect in any way the conclusions drawn from the number of marks or the extent of marks and the influence they exercise on mortality and type.

Another argument is that the immunity of revaccinated smallpox attendants is observed also in those employed in nursing other infectious diseases. This is emphatically not the case. Every fever hospital in its annual report gives a list, long or short, of nurses who have contracted the illness on which they have been in attendance. I have seen nurses take every disease—typhus, enteric fever, erysipelas, diphtheria, scarlatina, measles, rubella, chickenpox, and whooping-cough. Smallpox alone is a safe disease to nurse, always provided the nurse is revaccinated. If not, nurses will take it as readily as any other infection; witness the experience of Leicester, where several contracted it.

The anti-vaccinationists claim that the general reduction in smallpox mortality is due to improved housing and sanitation. It is doubtless true that typhus, a disease especially associated with overcrowding, has almost disappeared from this country, and that enteric fever, caused to a great extent by contaminated water or milk, is rapidly decreasing with improved hygienic conditions. But if we take the diseases more analogous to smallpox, that is the exanthemata, we find that they are as common as ever. There is not the slightest sign to suggest that either measles or scarlatina is any less prevalent now than a century ago, and the first-named fever is at least as fatal as it ever was. As regards other infectious diseases, whooping-cough remains as a frequent cause of death in young children and absolutely unaffected by sanitary improvements.

As long as arm-to-arm vaccination was practised, some of the objections raised by its opponents were not without weight. The possibility of the transmission of such diseases as syphilis or tuberculosis was always present. The wonder, indeed, is that such an extremely small number of accidents happened. Nowadays, however, with properly prepared glycerinated calf lymph, this element of risk is removed. The only danger is septic infection. The possibility of this should always be before the operator, who should remember that carelessness on his part discredits the practice of vaccination. Doubtless, when sepsis occurs, it is often due to the wound becoming infected at a later period through the carelessness of the mother or nurse. Erysipelas is very occasionally observed. But it may be broadly stated that the risks of vaccination should be no greater than the risks which follow any other scratch. The most trivial breaches of the cuticle have been known to be followed by septicæmia and death. But nevertheless a scratch is not usually considered a source of danger.

Anti-vaccinationists go so far as to suggest that the greater prevalence of cancer, that the recrudescence of leprosy in certain countries, and that the defective teeth and imperfect vision of modern times are all due to the devastating results of vaccination in infancy. It is impossible to treat these speculations seriously.

Conclusions.—By the judicious practice of vaccination and revaccination it is quite possible to effectively banish smallpox from any given country. Revaccination should be performed at from seven to ten years of age, and again at the age of eighteen or twenty. Thereafter the presence of smallpox in the neighbourhood would render further revaccination advisable if more than five years have elapsed from the last effective

vaccination. If a revaccination, however, has failed, it would be unsafe to assume the immunity has persisted for as long as five years, and any one who is liable to exposure should be once more revaccinated, if the circumstances demand it, before that time has passed.

CHAPTER VIII.

CHICKENPOX.

Etiology.	Severe Types.
Period of Incubation.	Diagnosis.
Stage of Invasion.	Prognosis.
Stage of Eruption.	Isolation and Quarantine.
General Course.	Treatment.

Synonyms—Varicella; Crystal Pox.

Etiology.—Chickenpox is unquestionably a perfectly distinct disease from smallpox. It confers no immunity against smallpox or vaccinia, and neither of these conditions gives any protection against chickenpox. During an outbreak it “breeds true,” that is to say under no conditions does it give rise to smallpox. The resemblance between the two diseases, although at times confusing, is only a superficial one.

The causative micro-organism has still to be identified. Quite possibly it will be found to be of protozoal nature. Chickenpox has no characteristic *season*, although possibly it is slightly more prevalent in the autumn. *Sex* exercises no influence. As regards *age*, however, it is certainly most common in the first ten years of life. It can be contracted, nevertheless, at any age, and it should be recollected that it is not at all unusual to see adults affected by it.

Chickenpox is endemic in most large cities, and at

times shows epidemic prevalence. It is highly infectious. The *infection* is usually communicated directly from patient to patient, but it can be carried for short distances on the clothes of a healthy third person. It is probably only short-lived in fomites. The virus is no doubt inhaled by the infected person. It is believed to lie in the crusts left by the eruption, as is also the case in smallpox, but whether this is the case or not, the patient is infectious from the moment of his first symptom, possibly indeed before any signs of the eruption have appeared. Recent observations suggest that the infectious period is of short duration, and does not last as long as the crusts remain on the body, the patient possibly being free of infection as early as the ninth day. This view, however, requires corroboration. The disease is spread chiefly by the aggregation of children in infant schools.

Period of Incubation.—The extreme limits may be placed at eleven and twenty-four days respectively. The usual time is from twelve to twenty-one days, and in the vast majority of cases the first symptoms are noted from thirteen to sixteen days after exposure to infection.

Stage of Invasion.—A definite prodromal period is wanting altogether in most cases of chickenpox, the appearance of the eruption being the first recognizable sign. But in a small minority of instances a fairly well-marked invasion stage does exist, varying from a few hours of slight malaise and "crossness" in children to a well-defined fever of two days' duration. Adults particularly are liable to suffer from some prodromal pyrexia accompanied by headache and feelings of chilliness, and even such a suggestive, if misleading, symptom as pain in the back is sometimes complained of. Children may vomit before the eruption is visible, and in rare cases convulsions may occur.

Prodromal rashes are not very rare. They are usually scarlatiniform and often limited to the trunk, and not infrequently lead to a mistaken diagnosis of scarlet fever.

It is well to remember, then, that in certain cases prodromal symptoms do occur. Otherwise, especially in dealing with adults, the fact that there was fever before the eruption might lead to a diagnosis of smallpox.

Stage of Eruption.—In most patients, however, nothing is observed before the eruption appears. Occasionally the stages of macule and papule may be seen, but the development is very rapid, and usually the *vesicle* has formed quickly enough to be the first obvious manifestation of the eruption. In shape it is either rounded or oval, elongated forms with somewhat irregular margins being sometimes met with. It lies very superficially, not being deeply set in the skin. At first the contents are extremely clear, so clear that, as the covering pellicle is very thin, the vesicles look almost like drops of water sprinkled on the skin. On the trunk the vesicles are soft and velvety to the touch. On the scalp and forearms, however, they tend to be somewhat more deeply set in the skin, and this gives them a harder, and sometimes even a “shotty,” feeling. The vesicles are unilocular, and collapse if pricked. Occasionally they are surrounded with a somewhat pale areola, which may become pronounced if the contents of the vesicle suppurate.

The vesicles do not come out all together, but continue to appear in crops for several days. The earliest are nearly always situated on the trunk. They do not as a rule remain long unruptured, few probably surviving for more than two days. Should they escape early rupture, either from scratching or the friction of clothes, the contents become cloudy and

PLATE V.



CHICKEN-POX.

[illegible]

pearl-coloured, and sometimes actually purulent. Once rupture has occurred, those collapsed vesicles which still contain a little fluid often become purulent, and occasionally, owing to the scab at the point of rupture tacking down the centre of the vesicle while the periphery remains distended with pus, an appearance of umbilication is given to the lesion. Many vesicles, however, desiccate from the moment of rupture with little or no pus formation. The *crusts* when they form are dark in colour, and usually consist of coagulated blood, as the spots are often much scratched. In outline they resemble that of the vesicle, that is to say somewhat oval crusts are common. If there has been much septic inflammation in the lesion there may be some burrowing of pus under the crust which tends to be set deeply in the skin, but in the vast majority of instances the crusts lie very superficially upon the skin surface and are readily detached. Scarring of a more or less obvious character may be left behind, and the *scars* left by deeply suppurating or gangrenous cases may be puckered and depressed. Ordinarily a very faint white oval mark is all that can be seen on the skin, but this may persist for life.

The *distribution* of the eruption, while not nearly so specialized as that of smallpox, in most cases follows a fairly definite arrangement. It is most profuse on the trunk, especially upon the back; it is well developed on the face and scalp, and is, as a general rule, scanty upon the extremities. The forearms and wrists in particular are in a very high percentage of cases entirely free from spots. Should the eruption be profuse on the limbs, as may be observed in exceptional cases, there is none of the grading of density which is noticed in smallpox, the upper arm and forearm often suffering to an equal extent, instead of the distal part of the limb showing

a more dense eruption as is the case in smallpox. If there is any "grading" at all, it is just the opposite to that seen in smallpox, the chickenpox distribution tending to be centripetal rather than centrifugal.

The mucous membranes of the mouth are affected. Vesicles may often be seen on the *palate*, and are usually surrounded by a red areola. When they rupture, a greyish superficial ulcer remains visible for a day or two. The vulva also may present traces of the eruption.

The eruption in most cases is not profuse. Sometimes it may be represented by a single crop of about a dozen vesicles; occasionally even less appear, and there may be only one or two. In other patients, however, extraordinarily dense eruptions are observed, and it may be impossible to lay a finger on the back without touching one or more spots. In the average case the spots are from two to three inches apart and scattered very discretely.

General Course of the Illness.—It cannot be said that the *pyrexia* associated with chickenpox runs any definite course. Often, indeed, it is altogether absent. We have seen that in certain cases there may be prodromal fever, which is seldom severe. Later some degree of irregular pyrexia may accompany the appearance of the eruption. When the latter is profuse the fever may be considerable, mounting with the development of the vesicles, and resembling in some measure the secondary fever of smallpox, being usually proportionate to the density and suppuration of the eruption. If there is no fever, the only symptom is the irritation caused by the spots, which is often well marked. On the other hand, should fever be present, the usual symptoms associated with it will be present also, and headache, insomnia, loss of appetite, and even delirium, may be observed. The patient is very liable

to scratch and tear the vesicles, and scarlatiniform rashes, probably septic in origin, are not infrequently seen during the eruptive stage. The crusts may all be separated in a fortnight in mild cases, but it is often three to five weeks before the last has fallen off,

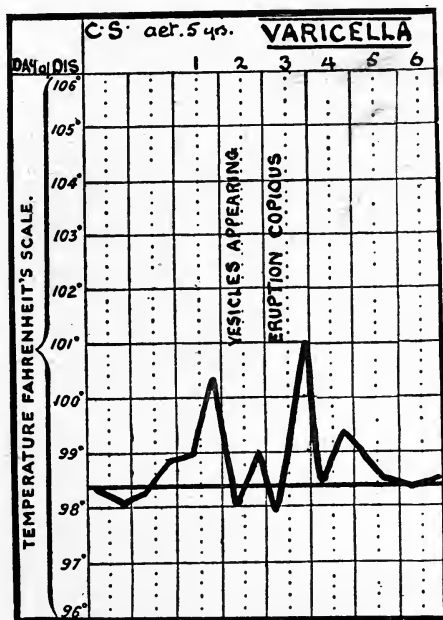


FIG. 9.—Chickenpox with some slight prodromal fever.

those in the scalp being particularly likely to cause trouble.

Complications.—These are rare, although in feeble children they are sometimes observed. Only three need be mentioned. *Laryngitis*, which, as in smallpox, is probably due to the vesicles affecting the larynx, is said to be dangerous in the eruptive stage, and might easily become obstructive. *Broncho-pneumonia* is very

rarely observed. *Nephritis* occurs occasionally, and may be severe. It must be remembered that many hundreds of consecutive cases may be seen without a single complication occurring. *Second attacks* have been reported but are extremely rare.

Severe Types.—A *hæmorrhagic* type, presenting hæmorrhages into the base of the vesicles and purpuric spots on the skin, has been described. It is not necessarily fatal. The *gangrenous* type is better known, and appears to depend on septic infection following an ordinary attack in a particularly feeble patient. There is suppuration below the crusts, with a tendency to burrow. Some necrosis of the surrounding tissues follows, and irregularly punched out ulcers are formed which sometimes eat deep into the subjacent structures. The process is a prolonged one, and is accompanied by low fever and marked wasting. If recovery follows, ugly depressed scars, often more than an inch in length, are left as the result. The gangrenous type of chicken-pox is, however, likely to terminate fatally.

Diagnosis.—The student is reminded that the diagnosis of chickenpox may in certain circumstances become a question of the highest importance owing to the great resemblance its eruption presents to that of *smallpox*. It is this fact that may be taken advantage of to prepare oneself for the recognition of the rarer and more severe disease. We cannot all see smallpox, —none of us at present can see it frequently,—but we all, by acquiring a really sound knowledge of chicken-pox, can save ourselves from the most obvious pitfall in smallpox diagnosis.

For the distinctions between the two diseases the reader is referred to the section devoted to the subject in the chapter on smallpox. It will be sufficient here to emphasize two points: first, that the distribution of the two eruptions is entirely dissimilar; and, second, that

the recognition of one or two really typical chickenpox vesicles of the long oval type is often enough to clinch the diagnosis. The student is warned again that while the history of prodromal symptoms should always be carefully investigated, undue weight must not be attached to it. Still, a case which with well-marked initial fever has only a very scanty eruption is more likely to be varioloid than chickenpox, the latter disease seldom presenting prodromal symptoms unless the subsequent eruption is profuse.

Certain *skin diseases* may be confused with chickenpox. Of these impetigo may be mentioned. Its distribution is usually on the face, but occasionally the rest of the body is invaded. In the crusting stage particularly it may resemble chickenpox. Herpes should not be readily mistaken, its localized arrangement giving sufficient indication, though the individual lesions are not unlike chickenpox vesicles, and, if scattered, as in the "generalized" type of the disease, may cause confusion. Dermatitis herpetiformis, while presenting suspicious-looking vesicles, does not show typical oval forms, and the lesions continue to appear over a period much longer than would be possible in chickenpox. Pemphigus occasionally shows very small vesicles at first, but they develop so rapidly into large bullæ that the mistake, if made, is soon corrected. To distinguish all these conditions we have the distribution of the lesions, and the presence or absence of one or more really typical chickenpox vesicles to help us.

Prognosis.—There is practically no mortality in uncomplicated cases. If death occurs, it is only in patients who have been attacked by chickenpox when exhausted by some acute fever or prolonged illness. In such individuals the eruption may become gangrenous and death may follow. Otherwise the outlook is uniformly favourable.

Isolation and Quarantine.—Until the question of the infectivity of the crusts is settled the patient should be isolated till the last one has separated from the skin. It is unwise to allow a child to mix with others before two weeks have elapsed from the first symptom. The quarantine period should be three weeks. Although, in rare instances, longer incubation stages have been reported, this has proved amply sufficient in my experience. As in the case of rubella it seems worth considering whether isolation of contacts from the tenth to the twenty-first day after exposure is not sufficient.

Treatment.—It is well to keep the patient in bed for the first week or ten days at least, and, if the eruption has been profuse, for a longer time. The possibility of nephritis should be remembered, and when the patient is allowed up he should be warmly clad and protected from draughts. If there is fever, a light diet should be prescribed; otherwise ordinary food may be given. If the skin irritation is very severe, a dusting powder of boracic acid, zinc oxide, and starch, equal parts, should be used. The arms of children who are constantly scratching themselves may with advantage be controlled by light poroplastic splints. When the crusts are separating, a little zinc ointment may be rubbed on any sores left. The gangrenous type of chickenpox calls for liberal feeding and free stimulation, and the ulcers should be carefully treated and dressed. Complications must be dealt with on the usual lines.

CHAPTER IX.

TYPHUS FEVER.

Introduction.	Relapses and Second Attacks.
Etiology.	Morbid Anatomy.
Period of Incubation.	Diagnosis.
Stage of Invasion.	Bacteriological Diagnosis.
Stage of Advance and Eruption.	Prognosis.
The Nervous System in Typhus.	Treatment.
The Crisis.	Specific Treatment.
Stage of Convalescence.	Isolation and Quarantine.
Types.	Prophylaxis.
Complications.	

Synonyms—Typhus Exanthematicus; Jail Fever; Camp Fever; Ship Fever; Brill's Disease.

Introduction.—This disease has now an interest which is chiefly historical so far as this country is concerned, yet it was once so generally prevalent that Murchison has said that a complete history of the fever would be the history of Europe during the last three and a half centuries. The various names by which it has been known suggest the ravages for which it was responsible in the crowded prisons, camps, and fleets of the seventeenth and eighteenth centuries. It has, however, been practically stamped out by such sanitary measures as the improvement of dwelling-houses, the opening up of congested areas, the destruction of slum property, and the notification of infectious diseases. The fever, nevertheless, is still common in Eastern Europe, and its extraordinary prevalence since

the war has caused it to be regarded as a real menace to this country.

Etiology.—That the virus of typhus is in the blood of individuals suffering from the fever has been proved by the transmission of the disease by blood inoculations into various species of monkeys. It is still, however, uncertain whether the infecting agent is bacterial or protozoal. Plotz has described a bacillus, but his work remains unconfirmed. Minute, deeply staining, bacillus-like bodies have been observed by Ricketts, Prowazek, and others, while Futaki has discovered a spirochæte in the kidneys and urine of typhus patients and also in the bodies of lice.

Typhus seems to flourish best in a temperate *climate*, but it has a wide geographical range, and occurs in such hot countries as Northern Africa, Mexico, and India. During last century Great Britain and Russia suffered heavily from it. In this country its spread is to some extent influenced by *season*, the winter months favouring the development of epidemics, doubtless owing to the slum population spending more of their time indoors and crowding together to avoid the cold. Little influence is exerted by *sex*, and the fever can be contracted at any *age*, that between fifteen and twenty-five years furnishing perhaps the greatest number of cases.

The conditions which favour an outbreak are first *overcrowding*, which has always been especially associated with this fever, and second dirt and destitution.

The question of *dissemination* is of no little interest. The infection for long was held to depend upon the emanations of the patient, and it was remarked that the "striking distance" of the virus is a short one, that is to say that to contract the disease it is necessary to be in actual contact with, or at least comparatively close to, the sufferer. It is now satisfactorily proved by the work of Nicolle and others that the disease is

transmitted by the agency of the body *louse*. It is not improbable that the *pediculus capitis* also may be a source of danger, but it is stated that fleas and bugs play no part in disseminating the fever. Whether the virus can be transmitted in any other manner than by inoculation, as is the case in the pneumonic variety of plague, does not appear to have been definitely determined, but in the meantime we may regard the louse as the sole medium of transmission. Nicolle states that the insect can pass on the infection to its offspring, and the virus is apparently long lived in such *fomites* as textile articles and furs which in the past have been associated with the causation of outbreaks of the fever.

Period of Incubation.—This seems to be somewhat variable, but in the vast majority of cases is from ten to fourteen days. The extreme limits are four and twenty-one days respectively.

Stage of Invasion.—The onset is abrupt and well marked. Headache, vomiting, and definite feelings of chilliness are the most frequent invasion symptoms. The patient cannot keep warm, and is apt to sit over the fire or cover himself up with extra bedclothes. Convulsions may occur in children. As the temperature rises all the ordinary symptoms of fever and toxæmia are observed, and insomnia is common in adults. The patient is stupid from the first. His eyes are pink and watery, and a sense of prostration usually makes him take to his bed by the third day.

The temperature seldom reaches high levels at once, but mounts slowly and steadily until the fourth day, by which time the acme is usually attained. The pulse is full and quick, and the respirations are much increased in frequency.

Stage of Advance.—This may be said to commence with the first signs of the eruption, which usually

appears about the time the pyrexia reaches the acme, that is on the fourth or at latest the fifth day. The temperature is now maintained at a high level, 102° to 104° , with little or no morning remission. A typhus chart shows in many cases almost a straight line. Occasionally there may be a break, usually between the seventh and eleventh days, the temperature as it were attempting to fall, but soon regaining its previous

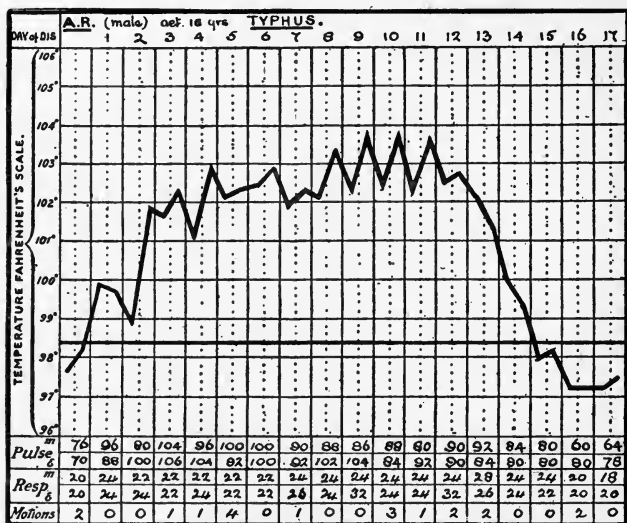


FIG. 10.—Typhus Fever. Illustrating a somewhat gradual onset and abrupt termination by crisis.

level. This pseudo-crisis, however, is only seen in a minority of the cases. The true crisis does not as a rule occur till the thirteenth day, though there may be a slight decline in the pyrexia as the second week progresses. Hyperpyretic levels are occasionally observed just before death in fatal cases.

The *eruption* appears first as pale pink spots, not unlike typhoid spots. They disappear readily on

pressure during the first few hours of their existence, but rapidly become stained into the skin and of a dirty brown colour. As to distribution, the rash invades the whole body except the face, and is most profuse on the trunk, especially on the back. The general appearance is somewhat measly. In addition to the spots there is some degree of "subcuticular mottling," best seen in the axillæ, and apparently due to the presence of spots which have not developed sufficiently to appear on the skin surface. Lastly, true hæmorrhage may either occur into existing spots, turning them a brownish purple, or independently of them giving rise to dark purple petechiæ which closely resemble louse-bites but lack the central scar. All these elements taken together form what Jenner described as the "mulberry rash" of typhus. The hæmorrhagic element is not always present, but is likely to occur in all severe cases. The severity of a case, indeed, is usually directly proportionate to the profuseness and intensity of the eruption. In children, who often take the disease lightly, the rash may be very scanty, and is sometimes entirely absent. The eruption remains visible throughout the fever, but has usually faded considerably before the crisis occurs.

A curious feature of the disease is the distinctive *odour*, which has been compared with that of mice and of rotten straw, and which is given off by many patients throughout the acute course of their fever. The *appearance* of the patient is often very suggestive. The features are bloated, the face congested, and the expression "drunken." The conjunctivæ are pink, and the pupils as a rule markedly contracted.

During the early stages of the fever the *pulse*, while increased in frequency and usually over 100, is not very rapid. As the illness advances it is liable to become much faster, and is apt to be small and of a

low tension. Some irregularity may be observed. The *respiration* has been fast from the first, and, with the tendency to hypostatic congestion of the lungs in the second week, becomes still more rapid, 40 per minute being a quite common figure towards the end of the fever. Some cyanosis is often present. Many patients suffer from cough.

The *tongue*, which in the first few days of the fever has been covered with a close white fur, becomes dry and brown about the time the eruption appears. Thereafter, if not carefully attended to, it becomes crusted, cracked, and fissured, and in severe cases shrivelled up and pointed. The lips and teeth are covered with sordes. Thirst is a prominent symptom at first, but is less complained of when the patient becomes more stupid. The bowels are usually constipated. The *urine* is reduced in amount and of a high colour. Albuminuria is almost invariable in adults, but is less frequent in children. The diazo reaction is always present in the urine while the fever remains acute. The *spleen* is in all cases definitely enlarged.

The Nervous System in Typhus.—The toxins of typhus appear to have a particularly deleterious effect upon the cerebral and nervous tissues. The headache is very severe in the early days of the illness. Giddiness is also frequently present. The intelligence is blunted, and there is much mental confusion and loss of memory. Deafness is a usual symptom. While the patient often appears drowsy he is apt to suffer from insomnia at night, and in most cases there is more or less delirium. This *delirium* is of two kinds, the excited type being most commonly seen in the first week of the fever. The patient may merely suffer from restlessness and excitement of the kind seen in delirium tremens, or he may get into an acutely maniacal

condition, the so-called *delirium ferox*. The latter is extremely dangerous both to the patient, who may do himself any sort of injury, and to his nurses, who may be seriously damaged in trying to control him. After the first week is over, the *prostration* of the patient is too great for delirium of this kind, and the low muttering type is the rule. He lies on his back, unable to do anything for himself, sometimes picking aimlessly at the bedclothes. His tendons twitch (*subsultus*), he loses control of his bladder and bowel reflexes, and either passes urine under him unconsciously or retains it too long and suffers from retention. Tremor affecting the limbs is noticed in bad cases. Coma not infrequently supervenes, and the patient may lie immobile with pin-point pupils staring at the ceiling. It is obvious that in such a state of helplessness and prostration bedsores are very liable to form unless the greatest care is taken.

It is this condition of profound prostration, accompanied by delirium, incontinence or retention, *subsultus* and so forth, and associated with a rapid pulse and increased respiration, which is known as the *typhoid state*. It may be said to be almost the normal condition in adults suffering from typhus, and is, of course, met with occasionally in all the other acute fevers. Typhus, in fact, may be taken as a sort of prototype of a severe toxæmia and of its effects on the heart and nervous system.

The Crisis.—The patient, then, drifts as it were through the second week of his illness, usually unconscious, always helpless, and too stupid to ask for the water which he so obviously needs. About the thirteenth or fourteenth day he not infrequently succumbs to the intensity of the toxæmia, death often being heralded by a fairly well-marked rise in the temperature level (see Fig. I, p. 10). In most cases, fortunately, the

occurrence of the crisis at this date allows the case to terminate favourably. It may, however, be delayed a day or two, sometimes even till the-seventeenth day. The first sign of this welcome change is often an evening fall of temperature of about two degrees. Should the fall occur in the morning, it is apt to be better marked. The crisis is a slow one, often taking two or even three days to be complete. There is no heavy sweating, but the skin becomes moist, and the general appearance and symptoms of the patient rapidly improve. By the time the temperature has reached the normal line the appetite has often returned and the tongue become reasonably clean. Instead of a crisis, there may be a short lysis with well-marked evening swings. When the fall is completed, the temperature is apt to remain subnormal for some time. Sometimes, but rarely, death occurs after the crisis from exhaustion.

Stage of Convalescence.—The convalescence of typhus is remarkably rapid and uneventful, and the large amount of weight which is always lost in this fever is very quickly regained. A week after the crisis a patient is often quite anxious to leave his bed.

Types.—Typhus, like the other fevers, may present itself in an especially toxic form, and there is a type described under the name of *Typhus Siderans*, or "blasting typhus," which is fatal in two or three days from the onset and must closely resemble the fulminant form of cerebro-spinal fever. *Mild types* are comparatively common, and are especially frequently observed in children. The rash is scanty or restricted to the subcuticular element only, the mind remains almost unclouded, and the delirium is short-lived or altogether absent. The crisis tends to occur early, or the termination may be by lysis.

Complications.—Few acute fevers are so free

from complications as is typhus. During the illness *respiratory complications* may occur, and bronchitis sometimes proves troublesome. Laryngitis followed by ulceration and necrosis of the cartilages is occasionally met with. Lobar pneumonia is sometimes seen, and, as has been noted above, hypostatic congestion is so common as to be regarded rather as a symptom than a complication. The injudicious use of aperients may start a diarrhoea which is difficult to check, and which may be sufficient to turn the scale against a patient's recovery. *Venous thrombosis*, chiefly affecting the large veins of the left lower extremity, is a not very uncommon sequel. Nephritis is seen in rare instances. Meningitis and various forms of paralysis have been noted, and some mental weakness, fortunately of not very long duration, sometimes follows the fever. As after other exhausting conditions, the typhus convalescent may suffer from otitis media, boils, and small superficial abscesses.

The most common complication is perhaps *parotitis*, which is not infrequently seen in severe cases, and which usually is unilateral. It terminates by suppuration, and there is often extensive sloughing of the surrounding tissues.

Relapses and Second Attacks.—True relapse of typhus has been described, but is extremely rare. Second attacks are very uncommon.

Morbid Anatomy.—The skin may present traces of the hæmorrhagic eruption. Decomposition sets in early and proceeds rapidly. The internal organs are congested and not infrequently show small scattered hæmorrhages on the surface. The heart's substance is soft and friable and the cavities dilated. The blood is dark and fluid. The spleen is soft, enlarged, and occasionally diffuent. The cerebral membranes are markedly congested. Certain spherical or fusiform

dilatations of small vessels have been recently detected by histological examination in many of the organs, and especially in the brain in the neighbourhood of the aqueduct of Sylvius. They have been named *typhus nodules* and appear to be due to damage to the intima and a subsequent proliferative process in the vessel walls. The intestine shows no ulceration, a point which was found of much importance in the original differentiation of the disease from enteric fever.

Diagnosis.—It cannot be said that this should be difficult when the existence of an outbreak is known. The sudden onset, the early prostration, the congested face and pink eyes, and the characteristic rash should in most cases, if the possibility of typhus be remembered, make the recognition of the condition fairly easy. But if, on the other hand, we are dealing with a first case and are not thinking of typhus, diagnosis is very difficult, and is not rendered any easier by the fact that, occurring as this fever does among a slum population, the dirty condition of the patient often obscures the eruption. For these reasons the first cases of an outbreak are usually treated for other diseases. In coming to a conclusion, weight should be attached to a characteristic history of onset and to the presence of some of the elements which constitute the eruption. The axillæ should be examined for signs of the subcuticular mottling, and all apparent louse-bites carefully examined to see if the central white scar is present. If not, such spots might well be petechiæ due to typhus. The odour of the fever, if present, is of great value to those who can recognize it.

The diseases for which typhus is most commonly taken are lobar pneumonia, meningitis, influenza, measles, and, most important of all, enteric fever. As regards the first three of these, the complete absence of anything resembling the typhus eruption forms the

most important distinction, with this reservation, that in cerebro-spinal meningitis the skin hæmorrhages may be possibly numerous enough to cause difficulty. The rapid breathing so commonly seen in typhus and the high and steadily maintained pyrexia make a diagnosis of *pneumonia* not improbable, but although some dulness may be found at the bases of the lungs it will be found to be equal on both sides and not confined definitely by the limits of a lobe. Moreover, while crepitations are present, there is no tubular breathing. When the diagnosis lies between typhus and *meningitis* lumbar puncture may give useful information. In meningitis, moreover, the headache is more persistent, whereas in typhus it disappears when the delirium commences. Neck rigidity is not likely to be found in typhus, nor is Kernig's sign to be expected, and in meningitis, if purpuric spots are present, there is no subjacent rash.

A fading *measles* eruption often very closely resembles the rash of typhus, and if the temperature remains high owing to some such complication as broncho-pneumonia, a mistake is occasionally made. A history of the rash having been definitely seen on the face, or even better the stained remains of it still visible in that situation, puts typhus out of the question.

The distinction of typhus from *enteric* fever is more important, as a mild case of the former with little or no rash has a very close resemblance to the latter disease. The points in favour of typhus are first a sudden onset as against the more insidious appearance of enteric; second, the drunken, bloated expression so unlike the somewhat refined and hectic look of the enteric patient; third, the contracted pupils and injected conjunctivæ which contrast with the wide pupils and clear eyes of enteric fever; fourth, the absence

of the definite morning remission usually observed on enteric charts; and last, the presence of true skin hæmorrhages with definite subcuticular mottling which are not seen even in the most profuse enteric eruptions. It must be admitted, however, that all these rules, except the last, have exceptions, and the differentiation may be very difficult. We cannot even rely upon bacteriological assistance, as Wilson has satisfactorily proved that the Widal reaction cannot be depended upon in making this distinction. The diazo reaction is also useless, as it is present in both fevers.

Bacteriological Diagnosis.—There is, however, an interesting agglutination test, which is admitted to be of great value in the diagnosis of typhus fever. It is carried out with a bacillus, known as *Proteus* × 19, which has been recovered from the urine of many typhus patients and in some instances from the blood also, but which is not regarded as having anything to do with the causation of the fever. The bacillus is agglutinated by typhus blood in high dilution, and the results reported point to this test, named the *Weil-Felix Reaction*, being a very accurate one.

Prognosis.—In estimating the chances of a patient's recovery we are first influenced by *age*. The mortality rate among children is comparatively low, and in the third five years of life the prognosis is most favourable, the death-rate being only about 2 per cent. Thereafter it steadily rises, and is about 30 per cent. for persons over forty years of age. *Sex* has a certain influence, females having a much better chance of recovery than males. Heavy, muscular, or fat persons appear to take the fever more severely than do light, spare, and thin subjects. Alcoholics always do badly, suffering much from the excited forms of delirium and severe nervous symptoms.

As to the significance of the symptoms presented

by the individual patient, a profuse eruption means a severe case, especially if the hæmorrhagic element is well marked. Hypostatic purple staining of the back may be taken to indicate the approach of death. A tendency of the pyrexia to relax in the second week and to run at a slightly lower level than in the first may be regarded as a good sign, and well-marked morning remissions are favourable. Should the fever, on the other hand, tend to rise to high levels about the thirteenth day, the outlook is bad. So long as the pulse remains under 120 there is always good hope of recovery; when it exceeds 130 the prognosis is most unfavourable. Respirations of over 40 per minute and obvious cyanosis are of evil import, and such complications as bronchitis with much secretion, or diarrhœa, prejudice greatly the chances of a satisfactory termination. Much sweating at the time of the crisis is one of the worst of prognostic signs.

Treatment.—The general *management and nursing* of the patient are of great importance. He must be isolated from the first, and this should always be carried out in hospital, unless the circumstances are very exceptional. As far as possible the treatment should be carried out under “open-air” conditions. Free ventilation must be arranged, all windows left widely open, and a large amount of cubic space, 2000 to 3000 feet, allowed to each case. There need be no fear of cold, and it will be found that the free circulation of cold air is a useful sedative for the patient. The bedclothes should be light, a blanket and sheet being quite sufficient covering. The patient should be frequently sponged with cold or tepid water, and some antiseptic may be added to the water used, especially if the odour is very obvious. When the crisis occurs, extra blankets may be added to the bed,

and if the season is winter it may be advisable to remove the patient to a warmer ward.

It is necessary to emphasize the importance of the detection and destruction of lice, although one would not expect to find them allowed to persist in any disease in a well-nursed hospital. As the patient is most dangerous from this cause at his admission, the nurse should wear rubber gloves and an overall garment, the ends of which may with advantage be tucked into the boots. Once the patient has been properly disinfected, these precautions should be superfluous except in the crowded conditions of military nursing. It is a good plan to remove all body hair by shaving and to cut the hair of the head quite short.

The nurse will pay special attention to the toilet of the mouth, swabbing the teeth and gums and wiping out the whole cavity with some suitable antiseptic ointment. It is also her duty in this connection to see that sufficient water is taken by stupid and delirious patients. Great care must be taken to give the patient frequent opportunities for micturition and to prevent the bladder becoming distended. Delirious patients do not ask for attention and, as a result, retention and subsequently incontinence of urine are very apt to occur.

As to *diet*, that recommended for the acute stage of enteric fever is suitable also for typhus patients. After the crisis almost anything can be safely given, and the amount allowed may be rapidly increased. The patient should be supplied with abundant quantities of cold water to drink, and indeed the forced ingestion of large supplies of water is probably the best systematic treatment to adopt in this fever. The difficulties are often very great when dealing with delirious and resistive patients, but good nurses usually manage to force from 6 to 10 pints daily on each

case. Delirium and restlessness seem most favourably influenced by this treatment, which does much to favour elimination of toxin.

Most adult patients will require alcoholic *stimulation* sooner or later. If the medical attendant is in doubt, it is safer to administer alcohol than to withhold it. Children seldom need stimulation. Cardiac tonics are as a rule disappointing in their action.

There is no need to interfere with the *temperature*, and in this fever as in others, antipyretic drugs are both useless and dangerous. Cool sponges are usually quite sufficient to do all that is required. As to *insomnia*, it must be actively combated from the first, and no patient should be allowed to have more than one sleepless night. Sulphonal often gives good results, if 25 to 30 grs. are given in hot whisky early in the evening and followed, if necessary, by paraldehyde four or five hours later. If a patient on admission appear at all excited, it is wise not to wait to see if he will sleep but to treat him at once. Cases of *delirium ferox* will need mechanical restraint. It is useless and dangerous to try and humour them if the condition has once declared itself. *Constipation* nearly always requires to be dealt with in the first ten days of the fever. It is best to use enemata or very moderate, say one and a half drachm, doses of castor oil. It is much easier to set up *diarrhœa* in this fever than to check it. Should it occur, any beef tea or similar preparation the patient may be having should be stopped, limewater added to the milk, and brandy substituted for whisky if he is having stimulants. Sometimes an astringent mixture may be required. For the *headache* of the early days of the fever citrate of caffeine is often useful, but most relief is obtained by an ice bag applied to the head. In *coma* strong coffee has been much recommended.

The medical man in attendance should examine the bladder at least twice daily.

Specific Treatment.—Nicolle and Blaizot have succeeded in producing a serum which has given good results in a limited number of cases. While it is possible that this treatment will be generally employed in the future, there is no serum in the meantime available for use by the profession. Recent methods of treatment recommended are the intravenous injection of chlorine water and the internal administration of iodine.

Isolation and Quarantine.—A five weeks' isolation dating from the first symptom is amply sufficient. A fortnight's quarantine works perfectly satisfactorily, although in rare instances incubation periods exceeding this limit have been known to occur.

Prophylaxis.—The opening up of air spaces in the crowded slums of our great cities, the regulation of common lodging-houses, the pulling down of old tenements, and sanitary supervision generally, have already made large epidemics of typhus practically impossible in this country. Rigid isolation in hospital of the sufferers, supplemented by the quarantine in a receiving-house of the contacts, will rapidly check small outbreaks. Even when difficulties occur in enforcing quarantine, it is wise to send the contacts to the receiving-house for one night, to give them a disinfecting bath, to free them of lice, and to disinfect their clothes with steam. During their absence from home their houses can be disinfected and their rooms whitewashed. Infected vermin are not likely to survive this treatment. After the contacts have returned home, they can be kept under supervision by a competent inspector. Whenever possible, however, they should be kept in quarantine.

CHAPTER X.

ENTERIC FEVER.

Bacteriology.	Types of Enteric Fever.
Predisposing Factors.	The Paratyphoid Fevers.
Dissemination and Infection.	Complications and Sequelæ.
Pathology and Morbid Anatomy.	Diagnosis.
Period of Incubation.	Laboratory Diagnosis.
Stage of Invasion.	Prognosis.
Course of the Temperature.	Treatment.
Stage of Advance.	Systems of Treatment.
Results of Ulceration.	Serum and Vaccine Treatment.
Stage of Defervescence.	Management of Convalescence.
Convalescence.	Prophylaxis.
Relapse and Post-Typhoid Pyrexia.	Typhoid Vaccination.

Synonyms—Typhoid Fever; Gastric Fever;
Infantile Remittent Fever.

Nomenclature.—The recognition of the two paratyphoid fevers, A and B, has rendered it advisable to employ the term “enteric fever” in a generic sense, and to include under it the whole group of fevers caused by the allied bacilli. The name “typhoid fever” should be reserved for cases of infection by the bacillus typhosus.

Bacteriology.—The causative micro-organism of typhoid fever is the *Bacillus typhosus*, which was first described by Eberth in 1880, and subsequently investigated and successfully cultivated by Gaffky. It is a somewhat short thick rod with rounded extremities. In young cultures, however, elongated filamentous

forms are often met with. It is actively motile, as may be readily demonstrated by the examination of "hanging drop" preparations. The motility is due to the large number of flagella with which it is provided. The detection of these requires special methods of staining, but the bacillus itself stains well with carbol-fuchsin or carbolic methylene-blue. It is decolorized by Gram's method. Cultures, which may be made on agar, gelatine, or bouillon, grow slowly at ordinary temperatures and should be incubated at 37° C. A streak culture on agar presents a bluish-grey film of growth with no special characteristics, while a bouillon culture shows uniform turbidity.

The recognition of the bacillus is no easy matter. It is one of a number of micro-organisms which greatly resemble one another in their morphological appearances and their characteristics in culture. The bacillus coli communis, a normal inhabitant of the intestines, has many resemblances, not entirely superficial, to the bacillus typhosus, and between these two is an intermediate group of micro-organisms which resembles both, and of which the bacillus enteritidis of Gaertner and the paratyphoid bacilli are the most important. To make a satisfactory differentiation, the services of a skilled bacteriologist are always necessary.

The bacillus typhosus is to be found in many of the internal organs. It probably occurs in greatest numbers in the spleen, but is often easiest to isolate from the gall-bladder. It may be recovered from the Peyer's patches in the small intestine, the liver, the mesenteric glands, and more rarely from the kidneys and lungs. In life it may be obtained from the stools, blood, and urine of persons suffering from the fever, and in certain cases from the sputum also.

The toxin of the bacillus typhosus is an *endotoxin*, that is to say it exists in the body of the micro-

organism, but does not appear to be given off into surrounding media. Toxic effects can be produced by the injection of the bodies of killed bacilli, and this fact has been taken advantage of in attempts to procure immunization. The toxin is also held to be responsible for the necrotic changes in the lymphoid tissue of the Peyer's patches.

Predisposing Factors.—Enteric fever can flourish in almost any *climate*, and occurs in all parts of the world. It is endemic in most countries, with occasional outbreaks of epidemic prevalence. In Great Britain its most usual *season* is early autumn, but cases may occur at any time of the year. As regards *age*, it is a fever of early life. It is rare in infants, but is fairly common in children under ten years. The great majority of patients are from ten to twenty-five years of age. It is only rarely met with in persons over the age of sixty. As to *sex*, males suffer more frequently than females up to the age of forty-five. It is probable that such conditions as fatigue, overwork, ill-health, and so forth, predispose to the disease. Destitution and overcrowding do not play the same important part as they do in the production of epidemics of typhus, but recent observations show that the crowding of soldiers in tents does much to favour that contact infection which, it is now admitted, is a serious factor in some outbreaks. A change to new conditions of life and climate certainly renders a person more liable to take enteric fever if the possibilities of infection are present. Active military service, whether in standing camps or on the march affords most favourable opportunities for the development of typhoid epidemics.

Dissemination and Infection.—The bacillus typhosus is contained in the excretions of persons who are suffering, or have suffered, from enteric fever.

It seems beyond question that under certain conditions the bacillus may retain its vitality for a considerable period in the earth, and that the fouling of the soil with either fæces or urine may give it opportunities of ultimately infecting the human subject through the medium of dust or water. The various ways in which enteric infection may be disseminated can be briefly summed up as under.

(1) *Water.* Epidemics depending on a defective water supply have been only too common, a well-known instance being the great outbreak at Maidstone. The water may become contaminated by enteric sewage leaking through defective drainpipes and fouling the soil drained by the shallow well from which it is drawn. In the same way wells may become infected by rains washing into them bacilli from excreta carelessly disposed of by being thrown on the ground or on a midden. Even reservoirs may occasionally become contaminated by similar means. The detection of the bacillus in water is difficult, and in many outbreaks obviously due to water it has not been found. Its absence, therefore, must not be taken to indicate that a water is necessarily safe.

(2) *Milk.* This may become infected by the use of contaminated water to clean the milk-cans or to adulterate the milk, or the germs may be carried on the hands of an attendant who may be nursing a case of enteric fever. Or, as has been proved to be the case in some recent outbreaks, the attendant may be a "carrier," having suffered from enteric fever a long time previously. In any case, milk outbreaks are not uncommon, and the fact that the appearance and taste of the milk is unaffected by the typhoid organisms allows it to be consumed without suspicion.

(3) *Various articles of food,* such as celery, water-cress, ice-cream, and shell-fish, have on different occasions

given rise to typhoid outbreaks. Shell-fish in particular, both oysters and mussels, are responsible for a very large number of cases. They become infected by growing near sewage effluents along the shore and at the mouths of rivers. The other substances named are doubtless contaminated from the water, milk, or soil with which they have been in contact.

(4) *Dust* can undoubtedly carry the bacillus. Contamination of the soil and dry weather are all that is needed for such a means of transmission. It is probable that much of the enteric fever in the South African War was due to this cause, the dust either being inhaled and swallowed, or eaten with the food which it was so liable to cover. Again, the dust of dried stools on a sheet, subsequently inhaled as the nurse changes the bedclothes, would account satisfactorily for many instances of sick-room infection.

(5) *Flies*, and possibly other insects, are also capable of carrying the bacillus and contaminating food. In camps it is easy to see how a fly may first visit latrines and then crawl over various articles of food. In civil life the common house-fly is suspected of disseminating infection, and in Manchester it has been proved that enteric fever is most common about the season when flies are most numerous. Flies, however, are not likely to be dangerous in towns in which water-closets, and not privy middens, are in general use.

(6) *Fomites* such as bed-linen, blankets, and clothes soiled by enteric patients can also spread infection, laundresses and other persons who handle them being liable to contract the fever.

(7) *Carriers*, that is healthy persons who have had the fever and have retained bacilli in their intestinal canal or elsewhere for long periods, are also capable of disseminating the disease, and small sporadic outbreaks are, in all probability, often due to this cause.

Most of the reported cases have been of persons whose employment connected them with the preparation of the food of other people, and it is possible that a want of care in disinfecting the hands after defæcation is responsible for the contamination. Cooks, dairy-workers, and others have gone from place to place over a long period of years, setting up at intervals small and otherwise unexplained outbreaks of the fever. Bacilli have been isolated from such individuals thirty years after an attack of typhoid. It is probable that they are harboured in the gall bladder and intermittently excreted in the stools, and urinary carriers are not uncommon.

(8) *Personal infection* by direct contact has only recently been recognized as a likely method of transmission of the fever, but in the Spanish-American War the disease was noticed to spread among men occupying the same tents. In these cases it must be remembered the dust of the tent floor may be contaminated, as may be the clothes and blankets of the individual men. In hospitals nurses not infrequently contract the fever, doubtless in many instances through partaking of food with hands not surgically clean, and in others from inhaling the dust of dried fæcal stains on the patients' sheets. Infection, in other words, always comes from the excreta of the patient or carrier, and in contracting the disease by direct contact the bacillus is doubtless transmitted in one of the ways mentioned above.

Pathology and Morbid Anatomy.—However the bacillus finds its way to the human subject, it is probably in the vast majority of cases swallowed and obtains its first nidus in the alimentary canal. The lymphoid tissue in and in connection with, the small intestine is first attacked, and from that situation bacilli find their way into the blood stream, the condition

becoming one of *bacteræmia*. By way of the blood the bacillus is carried to the gall bladder, spleen, and bone marrow, and multiplies in all these situations. From the gall bladder it is excreted in large quantities into the intestine, and in the later stages of the disease may be readily recovered from the stools. The necrosis of the lymphoid tissue is probably due to the bacillary toxins, possibly owing to the endothelial proliferation, which they stimulate, occluding the blood vessels. Too much importance, however, must not be attached to the intestinal lesions, as in not a few fatal cases they are very trivial in character, and in some are even absent altogether.

The most characteristic lesions are those of the *Peyer's patches* and solitary glands in the ileum, the last few feet of the gut above the cæcum being most affected. For the first ten days or fortnight the process is one of infiltration with leucocytes, and the patch becomes pinkish in colour and somewhat raised above the level of the surrounding mucous membrane. This is succeeded by a stage of necrosis, the enlarged mass gradually sloughing away, either as a whole or in detached fragments. The slough is somewhat grey in colour and may be stained yellow on the surface. In abortive and mild cases it is probable that this necrotic process does not occur. By about the end of the third week the slough has probably separated and the typical *typhoid ulcer* is formed. It corresponds in shape to the outline of the Peyer's patch itself except in those cases where the sloughing process has been only partial. Its position is opposite to the peritoneal attachment of the gut, and its long axis is parallel to that of the bowel. Its edges are not indurated, and in these points, then, it differs from the tubercular ulcer. Its depth varies, the muscular coat being not infrequently exposed, while

sometimes the base is formed by the peritoneal coat alone.

The ulcer usually heals by granulation, and no cicatricial contraction results. A few weeks after the attack all that can be seen is the so-called "shaved beard" appearance, minute black dots on a greyish surface. The glandular tissue is not restored. In some cases, however, perforation occurs, the necrotic process gradually boring through the intestinal wall and ultimately forming a minute hole which allows the bowel contents to escape. More rarely the peritoneal base of the ulcer presents the appearance of being torn across, and sometimes the whole base is necrosed and, as it were, falls out, leaving a large hole.

A similar process takes place in the *solitary glands*. In many instances the glands in the large intestine also ulcerate, especially those in the neighbourhood of the ileo-cæcal valve. In prolonged cases the bowel wall shows very marked thinning and atrophy. The *mesenteric glands* are always enlarged, and are often somewhat softened. The *spleen* is dark in colour and is much enlarged, being sometimes three or four times its natural size. The heart shows degeneration of the cardiac muscle and is usually pale and flabby. Ulcerations are sometimes found in the larynx and pharynx, and the lungs of severe cases may show more or less hypostatic congestion.

Period of Incubation.—This is extremely variable, and possibly depends upon the amount of the virus taken. The limits may be put at one and twenty-one days respectively, but probably in most cases from ten to fifteen days is about the time. Nevertheless, periods shorter than ten days are relatively common.

Stage of Invasion.—The onset of enteric fever is insidious, the temperature, as will be noted below, rising gradually and slowly. Doubtless as a result of

this the patient is not prostrated from the commencement, but acclimatizes himself, so to speak, by degrees to his changed temperature level. The symptoms of this stage fall conveniently into two groups, those general manifestations which are inseparable from any condition of fever and toxæmia, and the local symptoms which are suggestive of infection by the bacillus typhosus.

In the first place, then, the patient suffers from feelings of discomfort and malaise. There may be slight shivering, and feelings of chilliness are often complained of, but true rigors are rare except in those unusual cases which commence abruptly. The tongue becomes furred, the mouth dry, and the appetite is lost. *Head-ache*, often frontal, is usually present, and giddiness is not uncommon. The patient may complain of indefinite pains all over the body and limbs. Insomnia is a frequent symptom, and towards the end of the first week the patient is often delirious at night. Profuse perspiration is noted in many instances, and may be followed by a sudaminal rash.

With these symptoms, which it will be noticed are common to all febrile conditions, the patient nearly always has more or less *abdominal pain* or discomfort. His bowels are seldom normal. Either constipation or *diarrhœa* is almost certain to be present. While the latter is much more significant from a diagnostic point of view, it must not be expected in more than half the cases. Constipation, indeed, is in some outbreaks the much more common condition. Another very suggestive symptom is *epistaxis*, which occurs in anything from 25 to 35 per cent. of the cases. Lastly, in some patients the bronchial catarrh which is usually present in the fever is a prominent early symptom, and a troublesome cough may be complained of from the first.

The stage of invasion may be said to last about a week, at the end of which the temperature has probably reached its acme.

Course of Temperature.—The pyrexia in enteric fever passes through three definite stages. For the first week it is “*ingravescent*,” for the second and third or even more weeks it is “*continued*,” while for the last week it is “*remittent*” in character. The rise during the invasion stage is step-like, each morning the level being higher than that of the morning before, though lower

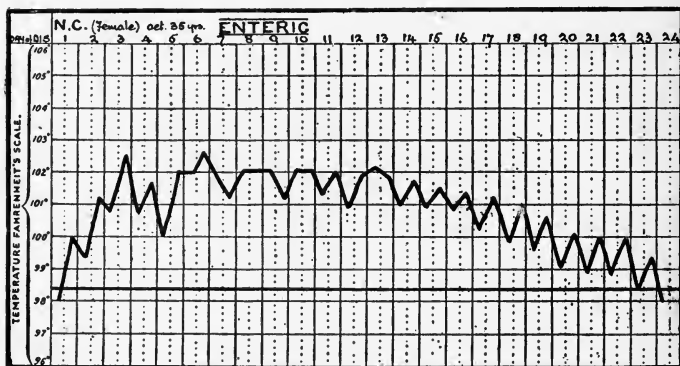


FIG. II.—Enteric Fever from the first day. Illustrating gradually rising temperature, a “continued” stage, and a typical lysis.

than that of the preceding evening. The acme having been attained, the temperature remains much at the same level, in an average case somewhere between 101° and 103° , though higher readings are not infrequently seen in severe attacks. A morning remission usually takes place, the fall being from half a degree to two degrees. If the period of advance is continued into the third week of the fever this remission is apt to be less well marked, especially in those cases in which ulceration is deep or extensive. In some patients, however, the remissions may remain

well defined even though the "continued" stage of the fever lasts for two or three weeks. The defervescence of the fever is by *lysis*, the temperature gradually relaxing and regaining the normal by more marked morning remissions, each morning showing a lower level. The evening temperature often descends more slowly, and may continue elevated for some days after the morning readings are normal. The lysis usually takes about a week, but is sometimes prolonged for ten days or a fortnight (see also Fig. 2, p. 11).

Hyperpyrexia is not common. Occasionally it occurs in association with rigors in the latter stages of the fever. High levels of temperature, however, 104° to 105° , are not infrequently observed in sharp cases, and may be maintained for some days. Sudden drops of temperature are often explained by such accidents as hæmorrhage and perforation, and unless accompanied by improvement in the pulse should be regarded with suspicion.

Stage of Advance.—By the end of the first week the patient has probably, though by no means always, taken to his bed. By this time he should, if examined, present many of the characteristic features noted below, but it must be remembered that some patients show very little more than continued pyrexia and splenic enlargement. With these symptoms, however, a somewhat slow dicrotic pulse, pea-soup stools, and a roseolar eruption are, at this stage, often associated. As the fever progresses the patient may tend to present "typhoid" symptoms with marked nervous prostration and cardiac weakness, and at any time after the end of the second week the ulcerative accidents of the disease are liable to occur. There is usually a marked degree of wasting, with great loss of weight. The stage of advance may be prolonged almost indefinitely, but as a rule does not exceed two weeks, and is very

often shorter. The symptoms presented may with advantage be considered in detail.

The *general appearance* of the patient is often suggestive. A slight, hectic-looking flush may be present on the cheeks, and the face is seldom congested. The conjunctivæ are clear, and the pupils are usually larger than normal. The expression is weary and apathetic. Should the fever be prolonged, the face tends to be more generally flushed, and in bad cases the pupils may become quite small, the appearances presented approximating to that of typhus.

The *tongue* from the first has been furred. By this time it is dry, and is often clean and red at the tip and edges. A small triangular clean glazed area is often noticed at the point. In the later stages of the fever, if attention has not been paid to the toilet of the mouth, the tongue, especially the centre of the dorsum, becomes brown, and not infrequently fissured and crusted. Sordes is usually present on the lips and teeth.

The *abdomen* is nearly always more or less tumid. In many cases it is much distended. Tenderness is frequent, and may be especially well marked in the right iliac fossa. Undue importance has been attached to the gurgling elicited by pressure in this region. Pain may still be complained of. The spleen is often readily palpable, especially in young children. It is always enlarged. The abdominal reflex is absent in the majority of cases.

The *eruption* is characteristic. It consists of scattered rose-pink lenticular spots, rounded and slightly raised above the surface, and disappearing readily on pressure. The spots make their first appearance about the seventh or eighth day of the fever, and are most frequently seen on the abdomen, back, and lower part of the chest. They may continue to come out in

crops for a week or longer, the life of each spot being from two to four days. In many cases the eruption is extremely scanty, only two or three spots being visible at the same time. More frequently, perhaps, as many as ten or twenty can be counted. In rare instances the eruption becomes general, the spots invading the limbs and even the face. It is probable that the rash occurs in the great majority of patients, but it has often disappeared before the case comes under observation. Children of under ten years of age are less likely to show an eruption than are older children and young adults. Bacilli can usually be cultivated from the spots, which may possibly be due to inflammatory irritation caused by the lodgment in the lymphatics of the skin papillæ of small masses of agglutinated micro-organisms.

The *stools* are by no means always loose, but when they are so they usually assume the ochre-yellow colour which has caused them to be compared with pea-soup. They have a peculiarly fetid odour. They contain particles of undigested food, curds of milk, and shreds of separating sloughs. Occasionally they are mixed with blood or contain isolated clots. If not pea-soupy in character, the stools do not present any distinctive features, but are seldom well formed.

The *pulse* is of low tension and, especially in the early stages of the fever, distinctly dicrotic. It is for the first fortnight slower than would be expected from the height of the temperature, seldom exceeding 100 in the male adult, but tends to become quicker in the later stages of a prolonged case. Women and children do not exhibit this relative slowness, and it is not unusual for them to have a rapid pulse throughout the illness. The first sound of the heart, as heard at the base, is often very feeble in the third week and later. Pericarditis and endocarditis are seldom ob-

served, the cause of the cardiac weakness being the action of the toxins on the myocardium. The *respirations* are at first accelerated in proportion to the level of the pyrexia, and seldom exceed thirty to the minute. In prolonged cases, however, the rate is somewhat quicker owing to hypostatic congestion. More or less bronchial catarrh is always present.

The *nervous symptoms* are often well marked. Head-ache has usually disappeared by the end of the first week, but insomnia is apt to be troublesome, and there is frequently delirium at night. This is usually of the low muttering type. Deafness is a very frequent symptom. In severe and sleepless cases subsultus of the tendons is common. More rarely the patient picks at the bedclothes. Retention and incontinence of urine are often noted. The great prostration of the patient is shown by his helplessness and by his inability to turn himself in bed, or even to lie on his side when turned.

In children particularly head symptoms are often observed, and the case may present a great resemblance to meningitis. Thus it is not unusual to see strabismus, vomiting, muscular rigidity, and the *tache cérébrale* in an uncomplicated enteric patient. Such a condition has been described as "meningism," and appears to depend upon the action of toxins alone, no actual brain lesions occurring.

The *urine* in the early weeks of the fever is scanty and dark-coloured. In the stage of defervescence the amount is increased, and there may be actual polyuria. Traces of albumin are to be found throughout the illness, but large quantities are distinctly unusual. Hæmaturia is extremely rare. The diazo reaction may be confidently expected in the urine from the sixth to the fourteenth days. After that time it is not infrequently found, but its presence cannot be

depended on. The bacillus typhosus is often present in the urine, probably in at least 40 per cent. of the cases. It is in the later weeks of the fever that it appears to be excreted in the greatest numbers.

The *blood* is chiefly remarkable for its comparatively low leucocyte count, a feature which distinguishes enteric from other acute fevers. From 5000 to 6000 leucocytes is a very common figure, and it is not unusual to obtain still lower counts, such as 2000 for example. The eosinophiles and polymorphs are reduced in numbers and the lymphocytes relatively increased. Bacilli may be cultivated from the blood, especially in the first ten days of the fever.

Results of Ulceration.—After the end of the second week of illness the necrotic process in the lymphoid tissue of the intestine has started, and there is always the possibility of the local condition in the bowel adding to the risks which the patient is already encountering as the result of the toxæmia. The ulcers may bleed or perforate, and it is more than probable that deep and extensive ulceration also plays a considerable part in the production of such dangerous conditions as meteorism and diarrhœa.

Hæmorrhage.—True ulcerative hæmorrhage occurring as it does after the first fortnight of illness is to be distinguished from the trivial congestive hæmorrhage which occasionally causes small quantities of blood to appear in the stools in the early part of the fever. It occurs in from 6 to 8 per cent. of patients, and is both more common and more severe in men than in women. Children of under ten rarely suffer from it. The amount of blood lost varies very considerably. One or two small clots only may be noticed in the stools, or, on the other hand, a great gush of blood may kill the patient in a few minutes. In an ordinary case the stools will be chocolate or dark red in colour from

admixture of blood, and may contain masses of clot. If the bleeding is only slight, the first indication of it will be the appearance of blood in the stool. When it is more profuse, the ordinary symptoms of hæmorrhage will be observed, the temperature falling, the pulse rising, and the face becoming pale. Copious hæmorrhage is attended by considerable shock, and the pulse becomes imperceptible, the temperature subnormal, and the respirations sighing. The patient is restless and anxious and suffers from air-hunger. If this stage of collapse is safely passed and there is no further loss of blood, the temperature gradually reaches its former level and the fever continues its course. Large hæmorrhages are often not repeated, and the patient may make an excellent recovery. On the other hand, the frequent loss of small amounts of blood over a period of several days is seldom followed by good results.

Perforation.—This, the most dreaded of all the possibilities of enteric fever, occurs in about 3 per cent. of the total cases. Like hæmorrhage, it is more common in men than in women, and is rare in young children. Its most common site is in the last 18 inches of the ileum, and usually it is within a few inches of the cæcum. But occasionally it is found in the appendix, the large intestine, or fairly high up the ileum. It seldom occurs before the end of the third week.

Sometimes the accident is preceded by pain for two or three days, and in many instances the temperature runs in a straight line without much remission for a day or two before its occurrence. But these signs are often wanting, and a patient who is apparently progressing favourably may quite unexpectedly be reduced to a condition of mortal danger. The first and most common symptom is sudden and violent *pain*. This is more likely to be noticed in patients who are not

stupid from toxæmia, as in the latter case the pain is but little complained of. With the onset of the pain the *temperature* often falls and there is marked collapse, but in some patients the level is unaffected, or, if the temperature moves, it is in an upward direction. The *pulse*, however, always increases in frequency. *Shivering* is sometimes present, and is a highly suggestive symptom. Vomiting may occur at the moment of perforation, but is more likely to be postponed till peritonitis becomes established. The face of many patients expresses *anxiety* from the first.

The situation of the pain is not of much importance. Often, indeed, it is epigastric, and it may be referred to any part of the abdomen. But on examination it is likely that *tenderness* may be localized in the right iliac fossa. The abdomen is held and does not move on respiration, and its tumidity is usually much increased, unless, indeed, as is not unusual, meteorism has been present before the accident. *Rigidity* of the abdominal muscles, sometimes unilateral, is a suggestive sign. Even at this early stage the liver dulness may be much diminished.

In a few hours the symptoms become those of peritonitis set up by the escape of bowel contents into the abdominal cavity. The abdomen becomes more distended and more resistant. The patient does all he can to limit its movements, and lies with his knees drawn up to relax the muscles. His face becomes pinched, livid, and anxious. His consciousness remains acute. Vomiting has now probably set in, and may be almost continuous. The pulse is irregular, thready, and extremely rapid. The temperature, if it has not previously fallen, now tends to do so, and till shortly before death is usually inconsiderable. Death may be expected to occur within three days. The condition, unless surgically treated, may be regarded as a hopeless

one. This renders its early diagnosis of great importance, as, when peritonitis has declared itself, not very much can be expected from surgical intervention. Rigidity of the abdominal muscles, taken together with an immobile abdomen and tenderness following on sudden pain with or without collapse, would in most instances justify operation. It should be remembered that a thorough acquaintance with the condition of a patient's abdomen gathered from daily examination gives us the best chance of appreciating sudden changes which in less carefully watched cases might be missed or disregarded. The nurse, moreover, should be made to understand the importance of instantly reporting such symptoms as the sudden appearance of pain or of even the slightest shiver or vomit. It may be mentioned that while blood counts are not altogether satisfactory in this connection a low count immediately after the accident is suspected is very much against it having occurred.

Diarrhœa.—This condition, if persistent and severe, is often associated with extensive ulceration. Three or four loose motions in the day need not be regarded as very serious, but a greater number cause much exhaustion and prevent the patient obtaining proper rest at night. Fortunately, in properly dieted cases diarrhœa is not a frequent condition. But, should it be severe, the risk of both hæmorrhage and perforation is always present.

Meteorism.—This is also often seen in badly ulcerated cases and is always to be regarded as a dangerous complication. The abdomen may be much ballooned and very tense, and occasionally the heart's action is embarrassed by the continued distension. Meteorism not infrequently is followed by perforation. The abdomen may nevertheless be very large and somewhat tense without any particular danger to the patient.

Meteorism, like diarrhœa, is most likely to occur in injudiciously dieted patients.

Stage of Defervescence.—After a more or less prolonged stage of advance, during which the patient has suffered from toxæmia to a greater or less degree, and has perhaps in addition suffered from one or more of the ulcerative complications of the fever, the lysis commences, the temperature gradually loosening its hold and slowly attaining the normal line. The appetite begins to return. Before, indeed, the stage of defervescence may be much advanced the patient is often ravenously hungry. He still may have delirium at night, especially if the temperature swings up to high evening levels, but during the day his general symptoms are much improved. The abdomen loses its tumidity, the abdominal reflex returns, and the spleen begins to decrease in size. Recrudescences of the pyrexia, however, not infrequently interrupt the lysis, and sometimes there is an exacerbation of the general symptoms sufficient to justify the name of an intercurrent relapse. Even after the normal is reached, fluctuations of the temperature are very liable to occur, and a true relapse may supervene at any time.

Convalescence.—This cannot be said to be reached till the evening temperature has been normal for about ten days or a fortnight. By this time the probabilities of a relapse occurring have become very remote. But even subsequent to this, complications are liable to appear, and the patient is still likely to be very feeble. He remains excessively hungry, and it is not unusual for an adult male to regain weight at the rate of over a pound a day. If the fever has been severe, some cardiac weakness may be left, and the pulse is sometimes at this time faster than it has been during the illness. The patient may also be childish and weak

mentally, but with rest and good feeding these symptoms usually pass off quite satisfactorily.

Relapse and Post-Typhoid Pyrexia.—By a relapse we understand a repetition of the fever, usually but not always in a shorter and milder form. It should bear sufficient resemblance to an ordinary attack of enteric fever to be recognizable as that disease, and it is this character which distinguishes it from febrile disturbance in convalescence due to other causes. It is usual to restrict the term to those cases in which, after a longer or shorter apyrexial interval, the fever is once more repeated, but exacerbations of the fever occurring during the lysis and accompanied by a renewal of all the characteristic symptoms of the disease, are doubtless due to similar causes and may be regarded as *inter-current relapses*. It is suggested that relapses are due to infection by bacilli of a different strain from those which caused the original attack, and against which the patient has therefore acquired no immunity. The view that additions to the diet will of themselves cause a true relapse may be dismissed, although injudicious feeding is undoubtedly responsible for many instances of pyrexia observed in convalescence.

The interval between the original fever and the relapse is usually short and very seldom exceeds a fortnight. It is often noticed that during this intermission the temperature is seldom subnormal, but tends to remain about normal with occasional rises to 99° at night. Once the temperature is steadily subnormal both night and morning, relapse is seen very infrequently. The spleen, moreover, is often found to be still large during the apyrexial interval, and it is possible that reinfection takes place from that organ, as is the case in relapsing fever. The first sign of the relapse is pyrexia. The temperature curve is often much like that in the original fever, though as a rule it takes a

day or two less to attain the acme, and abrupt onsets with high fever are more commonly observed than in the primary attack. The diazo reaction is usually found present in the urine by the third day. The eruption also, if present, tends to appear early. The abdomen again becomes tumid, and its reflex disappears. Ulcerative complications are rare in relapse, but the toxic symptoms may be severe. The fever is fortunately in most instances of short duration, from ten days to a fortnight on the average, although it may be prolonged for several weeks. Death is unusual.

Relapses vary in frequency from about 5 to 12 per cent., and females suffer more often than males. It may be noted in the latter connection that a relapse often starts at the time a menstrual period is expected, and in some women several relapses occur at succeeding periods.

From relapse must be distinguished the *post-typhoid pyrexia* which so often interrupts early convalescence. Such irregular rises of temperature are often due to injudicious additions to the diet, to constipation, and to similar causes. Pyrexia of this sort readily yields to a removal of the cause. It must be remembered that too rigid a diet after prolonged fever sometimes leads to a temperature of inanition, usually of a remittent character with high evening swings. This is best dealt with by increasing the amount of food allowed.

Types of Enteric Fever.—Of these may be mentioned the *toxic type*, which, as in other fevers, takes a hæmorrhagic form and is accompanied by bleeding from the gums, nose, and bowels, and purpuric spots on the skin. It is very rare, and always fatal. Secondly, the *ambulatory type*, in which the patient suffers from nothing more than slight malaise, and goes on doing his work for two or three weeks, when perhaps a

hæmorrhage or perforation prostrates him. Thirdly, the *abortive type*, in which the fever, though presenting quite recognizable symptoms, comes to a termination in something from a week to a fortnight. When a whole family is attacked, it is not unusual to see one or more members of it suffer from this abridged fever. Fourthly, the *apyrexial type* has the peculiarity of presenting fever without pyrexia. Every classical symptom of the illness except the pyrexia may be present, the wasting is as well marked as in patients with high fever, and the attack may be dangerously severe. The type is not a common one, but it is important as showing that a mere absence of temperature is not sufficient to exclude a diagnosis of enteric fever.

The Paratyphoid Fevers.—It has been suggested above that these fevers can be best considered as sub-varieties of the clinical entity, enteric fever. The bacilli which cause them have been classified as A, B, and quite recently C, and it is not improbable that yet further bacteriological refinements may be made. Clinically, however, the symptoms presented by these subvarieties are to all intents and purposes the same as those of typhoid fever, and from the public health point of view there is little to be said in favour of emphasizing the slight differences which may exist. On the other hand, if any form of specific treatment such as vaccine therapy is to be attempted, it is obviously necessary that the therapeutic agent should be prepared from the micro-organism actually responsible.

The incubation period of these fevers has been stated to be from nine to fifteen days. The onset is more abrupt, and is said to be more often attended by shivering than in ordinary typhoid fever. The case mortality, moreover, is generally admitted to be lower.

But all the symptoms and complications of typhoid fever may occur; hæmorrhage, perforation, meningitis, phlebitis, and "paratyphoid spine" have all been reported, and a definite diagnosis of paratyphoid fever does not allow us to give a prognosis much less guarded than in the case of typhoid infection. The B variety of the fever has been not uncommon in this country recently, having doubtless been introduced by carriers from the different theatres of war. The A type appears in the past to have been more frequently met with in India and the East.

Complications and Sequelæ.—Enteric fever may be found in association with very many other conditions which may either have preceded it or developed during its course. It will be necessary only to consider those complications and sequelæ which occur with comparative frequency or which are directly due to the bacillus typhosus. The association of the disease with *pneumonia* is of interest, as an inflammation of a lobar type may occur at almost any stage of the fever, and in some cases appears to be due to typhoid rather than to pneumococcal infection. This is particularly the case when it appears with the onset of the fever, and when its symptoms are so marked that they mask those of enteric, the latter not being recognized until the illness has lasted some time. The sputum of such patients may contain the typhoid bacillus. This type of the disease has been called pneumo-typhoid, and the course of the case suggests that the infection of the lungs may have been primary. An ordinary pneumococcal pneumonia, however, not infrequently complicates the fever, and can be distinguished from the hypostatic congestion which is so often observed, by its unilateral situation and its limitation to a particular lobe.

Just as enteric fever may be ushered in by a pul-

monary condition, so it may be associated from the first with a renal inflammation. In this type, sometimes spoken of as nephro-typhoid, all the symptoms of acute *nephritis* are noted from the onset. This is often followed by pyelitis, and the complication must always be regarded as a grave one. Fortunately it is rare, as is also nephritis occurring in the course of the fever.

The above complications, however, though occasionally due to typhoid infection, cannot be regarded as the ones characteristic of the fever. Of the latter probably the most important and most common is *venous thrombosis*, which is particularly liable to appear during the stages of defervescence and convalescence, and most frequently affects the veins of the left lower extremity. The femoral, the internal saphenous and the popliteal veins are those most likely to be thrombosed. The symptoms are oedema of the affected limb, irregular pyrexia and pain, the latter being first noticed. Typhoid bacilli have been isolated from the thrombi and from the vessel walls, and the lining endothelium has been found destroyed at the situation of the clot. Some local damage of this nature probably determines the commencement of coagulation at a particular point. The condition has been attributed to the great coagulability of typhoid blood in the stage of convalescence, owing to the exclusive milk diet with its excess of calcium salts. The preference for the left lower extremity may be explained partly by the fact that the rectum, often overloaded in convalescence, presses on the veins of that side, and partly by the pressure of the left common iliac artery on its attendant vein. The oedema of the affected limb usually lasts for a week or fortnight, detachment of thrombus is rare, and the patient may be expected to make a good recovery.

The complication occurs in from 2 to 6 per cent. of all cases.

Arterial thrombosis may also follow enteric fever, and is due either to embolism or an obliterative arteritis. The symptoms are pain, cessation of pulsation of the affected vessel, and coldness of the limb as compared with the other side. Dry gangrene may follow, but the limb is sometimes saved by the collateral circulation.

Periostitis, due either to the typhoid bacillus or to pyogenic organisms, is a well-known, if not common, complication. Almost any bone may be affected, but the tibia is the usual site. The ribs and femur suffer next in frequency. The first symptom is pain, and a small node or swelling may be palpable on the affected bone. This usually goes on to suppuration, the swelling becoming tense and red. Necrosis with exfoliation of bone often follows. The complication usually appears in convalescence, sometimes after the patient has been allowed out of bed, and occasionally the exciting cause is a trivial injury.

The condition known as *typhoid spine* may have some relation to these periosteal inflammations, and it has been suggested that it is an osteomyelitis due to septic emboli. Suppuration, however, does not occur, as is the case when other bones are inflamed, though the spinal deformities which sometimes result point to the bones being definitely implicated. It is now proved by radiography to be a spondylitis, the alteration being in the inter-vertebral discs, which show a density equal to that of the vertebral bodies themselves. Some peri-spondylitis is usually present. The symptoms are pain and rigidity of the spine, the back being held stiffly to avoid movement. The lumbar region is the characteristic situation. Tenderness, pyrexia, incontinence of urine, and exaggerated knee-

jerks are among the symptoms which have been observed. The condition sometimes exists for months, but the prognosis appears to be good. It is a most uncommon sequela of the fever.

Various suppurative and septic complications are apt to occur with or after the fever. Of these, *parotitis* may be mentioned, due in all probability to septic infection from the mouth, though in some cases the bacillus typhosus has been found in the pus. The inflammation, as in typhus, is unilateral and always suppurates. It is only seen in severe cases. Superficial skin *abscesses* are common in convalescence, particularly in children, as is also *otitis media*. *Cancrum oris* may also occur in debilitated and badly nourished children.

It has been mentioned above that laryngeal ulcerations are occasionally seen at post-mortem examinations. *Laryngitis* is not very common, but it may be in certain cases severe enough to demand operative interference. Hoarseness, pain on swallowing, and recurrent attacks of dyspnoea are its chief symptoms, and it is usually only observed in the course of severe and prolonged attacks. It results in ulceration and necrosis of the cartilages, and is one of the most serious and ominous complications of the fever.

Some degree of *cholecystitis* is probably not uncommon. We have seen that the gall bladder is a very frequent nidus for the typhoid bacilli, and occasionally their presence is responsible for the inflammation. If the condition is well marked, swelling below the costal margin, tenderness and pain in the right upper quadrant of the abdomen, with sometimes a slight degree of jaundice, would cause its presence to be suspected. There seems to be no doubt that typhoid bacilli often assist in the causation of gallstones, and it is probable that if the gall bladder is inflamed

during the fever the patient is particularly likely to be a "carrier" for long afterwards. The complication sometimes terminates fatally during the fever by perforation of the gall bladder.

Many *nervous complications and sequelæ* have been described, but their comparative rarity renders a detailed description unnecessary. True suppurative meningitis due to the bacillus typhosus is sometimes met with, and must not be confused with the comparatively common symptom-complex known as "meningism," which depends rather upon the toxins than the micro-organisms themselves. Cerebral thrombosis, hemiplegia, and paraplegia may all follow an attack of the fever. Convulsions only occur in a very small percentage of the total cases, and are seldom noted as an initial symptom. More common is neuritis, which is a prolonged and troublesome sequela of the disease, usually, however, only appearing in alcoholic subjects. An interesting condition of this nature is "tender toes," a complication observed chiefly in those who have been treated systematically with cold baths. The toes become extremely hyperæsthetic and cannot even bear the weight of the bedclothes. It is a short-lived condition, seldom lasting more than a few days. Mental diseases, possibly due to cerebral anæmia, occur in a few instances after enteric fever. Mania, melancholia, and dementia are all possibilities. Fortunately the prognosis of such cases is generally speaking a good one.

Enteric fever may coexist with *other infectious diseases*. Influenza, in particular, is not infrequently associated with the disease from its onset. Scarletina, measles, diphtheria, chickenpox, and erysipelas are also found as complications. Tubercular conditions may coexist with the fever, and phthisis, previously latent, may become active as the result of an attack.

An attack of enteric fever is very liable to interrupt *pregnancy*, from one-half to two-thirds of pregnant women aborting during its course. The abortion may be due to endometritis, prolonged high temperature, or to infection of the fœtus by the bacillus. In premature delivery the child is usually born dead, or only lives a few hours. The prognosis as regards the mother is not particularly serious. The bacillus is on occasion found in the fœtal blood, and still more frequently the latter gives a positive serum reaction. The death of the fœtus may be regarded as due to toxæmia.

Diagnosis.—The only absolute proof of enteric fever is the isolation of a bacillus of the enteric group from the blood of the suspected patient. Short of this, diagnosis must depend on the appearance in varying combinations of certain signs and symptoms, none of which are constant and many of which are not infrequently absent. The serum reaction, if not infallible, is undoubtedly of the greatest assistance.

Clinical Diagnosis.—The commencement of the fever is so insidious that the patient seldom seeks medical advice until he has been ill for some days, often indeed a week. The student must remember that, although in hospital he has gathered his ideas of enteric fever from the observation of cases lying in bed, in practice it is not unusual for the patient to walk into his consulting-room. In such a case the first complaints are often suggestive of digestive trouble, such as malaise, abdominal pain and discomfort, and, if the temperature is not taken, the patient is very liable to be treated for gastric catarrh, a condition which the state of his tongue strongly suggests, and which is undoubtedly present. The comparatively slow pulse of the male adult at this

stage may lead the practitioner to think no fever is present, but if the thermometer is used it will probably be found that there is more pyrexia than a simple gastric catarrh would warrant. In other cases the patient may complain chiefly of bronchial trouble, which may be very misleading.

If, however, the patient is first seen in bed about a week after the onset the diagnosis is less confusing. His temperature will be found elevated, and a study of his history will probably bring out the fact that this febrile condition has existed from the first. Thus a history of such symptoms as loss of appetite, loss of sleep, feelings of chilliness, insomnia and perhaps delirium at night, all point to fever, and we may assume that this fever has lasted from the date of the first symptom. Now, if with continued fever there is a history of such suggestive signs as diarrhoea, abdominal pain or epistaxis, either singly or in conjunction, the presumption in favour of enteric fever is already strong. Any or all of them should cause the possibility of that disease to present itself to the mind of the practitioner. It need hardly be added that if any record of the patient's temperature for a day or two previous has been kept, the gradual zigzag rise so often observed in the chart is highly suggestive.

Once the possibility of a case being one of typhoid is grasped, it is unlikely that any of the characteristic signs will be missed during the physical examination of the patient. The expression and appearance may, like the history, be suggestive of the fever. The pulse may, especially in male adults, be found relatively slow in proportion to the level of the temperature, and its dicrotism may attract attention. Even if, as is usually the case in women and children, the temperature-pulse ratio is normal, there is still the examination

of the abdomen to assist us. The presence of typical lenticular spots is practically final. Even spots which are not quite typical, which for instance are not definitely raised or which fail to disappear completely on pressure, may give some assistance. They are at least suggestive. Abdominal tumidity is to be expected. A hollow or flat abdomen may be said to exclude enteric fever. A large palpable spleen, such as is so often seen in children, is a strong point in its favour, and, on the other hand, if the practitioner can satisfy himself by percussion that the spleen is not enlarged, he should hesitate before he definitely diagnoses the fever. Splenic enlargement is perhaps the most constant of all the conditions which, taken together, make up the picture of enteric fever. As regards the stools, a pea-soupy appearance taken in conjunction with other points may be of some corroborative value, but it must never be forgotten that this characteristic may be noticed in the dejecta of patients suffering from other acute febrile diseases, particularly if the diet has been one of milk injudiciously administered. The absence of the abdominal reflex is also suggestive, yet a certain proportion of enteric fever patients pass through their whole fever without this reflex being abolished. On the other hand, unless nervous and abdominal conditions can be excluded, its absence does not assist the diagnosis.

The effect of the toxins on the inhibitory action of the vagus has been made use of by Marris as a means of diagnosis, particularly in the case of inoculated subjects who give positive serum reactions whether they suffer from the fever or not. He has devised the *atropine test*, which consists in first taking counts of the pulse for ten minutes, then injecting $\frac{1}{33}$ of a grain of atropine, and twenty-five minutes later counting the

pulse for ten minutes more. If the mean of the counts after injection exceeds that of the original counts by more than fourteen, the test is negative; if less, it is positive.

Differential Diagnosis.—It must be admitted that in many cases the diagnosis of enteric fever largely rests on the exclusion of other conditions. It will be well, therefore, to comprehend fully what these other conditions are likely to be. In a long series of over two thousand admissions to the enteric wards of the Edinburgh City Hospital, it was found that the diseases most frequently confused with enteric fever were conditions affecting the respiratory system, no less than three-eighths of the cases wrongly diagnosed falling into this category. The most common of all was acute lobar pneumonia, and the broncho-pneumonia of children also caused numerous mistakes. Other diseases affecting this system were acute tuberculosis, phthisis, and pleurisy with effusion. It is interesting to note that abdominal and pelvic conditions on the one hand and cerebral inflammations on the other, though both quite common in the series, were rare in comparison with the respiratory diseases above mentioned. One of the first and most important rules in diagnosis is therefore to examine the lungs carefully before assuming any patient is suffering from enteric fever. A respiration rate of over 30 in an adult should always be regarded with suspicion, especially if the patient is not more than a week ill.

It will be sufficient to give briefly the main distinctions between enteric fever and the diseases most frequently confused with it. *Lobar pneumonia* has in most cases a much more abrupt and well-marked onset than is seen in enteric. It is unusual for the respirations to be less than 30 per minute, a rate

which is seldom reached in the early stages of an enteric case. The pulse also is faster, and dirotism is not frequent. Difficulties may arise even after careful examination of the chest, as it may be some days before the physical signs are decisive, and in their default the medical attendant may assume that the case is one of enteric fever with exaggerated chest symptoms. In such circumstances the presence of herpes on the lips would point to pneumonia, as it is very rarely observed in typhoid. The presence of a diazo reaction in the urine would mean little, as a case of pneumonia occasionally, if rarely, shows it. Its absence, however, at the early stage of illness, when the difficulty is most likely to arise, would be much against enteric fever. As to blood enumeration, a low count, 6000 or under, would almost negative pneumonia. It must always be remembered that the two diseases may coexist, and that therefore pneumonia, even if obvious, may be present merely as a complication. *Broncho-pneumonia* in children is not infrequently thought to be enteric fever. The physical signs are often unsatisfactory, but the rapid breathing, the tinge of cyanosis, and the movements of the alæ of the nose should in most cases be sufficient for its diagnosis. The spleen is seldom much enlarged. On the other hand, abdominal tumidity and diarrhoea are not uncommon, and doubtless in many instances account for the mistake.

Perhaps the most difficult of all distinctions is that between enteric fever and *acute miliary tuberculosis*. Not infrequently it is only the persistence of a negative Widal reaction which convinces the practitioner that the diagnosis of enteric fever is incorrect. The temperature resembles that of the advance stage of enteric, the respirations may be moderate, the spleen somewhat enlarged, and the diazo reaction is usually

present. Physical signs on auscultation may be completely wanting. The most suggestive sign is perhaps the slight tinge of duskiness or lividity which is sooner or later noted in most cases of this kind. Ultimately the respirations become much accelerated and the nature of the condition is made clear, but earlier in the illness it may be quite impossible to come to a definite conclusion. A persistently negative Widal accompanying a brilliantly positive diazo reaction should cause acute tuberculosis to be suspected.

Tubercular meningitis also causes difficulty. Vomiting and convulsions are much more likely to occur during its course than in enteric fever, and the headache is also much more persistent, being apt to continue even when the patient has become delirious. In some cases extreme slowness of the pulse goes far to negative enteric fever, but this sign is often wanting. Retraction of the abdomen, on the other hand, develops very quickly in tubercular meningitis, and is a valuable distinction in making a differentiation, as the enteric abdomen is nearly always at least slightly tumid. Kernig's sign points to meningitis, but is occasionally noted in typhoid meningism. Optic neuritis, or the presence of tubercles on the choroid, should be looked for, and some information may be obtained by lumbar puncture.

Tubercular peritonitis is occasionally diagnosed as enteric fever. The appearance and expression may be very suggestive, and, taken together with the tumid abdomen and pyrexia, cause the mistake. The examination of the abdomen and the appreciation of glands or fluid will often clear up the difficulty, which, however, may be great in the earlier stages of this tubercular condition.

In the examination of the abdomen of a suspected case of enteric fever some local cause for the symptoms

is not infrequently found. *Appendicitis* is sometimes treated as the fever, and cases of the fever, on the other hand, have undergone operation for appendicitis. While tenderness in the right iliac fossa is often present in enteric fever, it is seldom so marked or so localized as it is in appendicitis. The absence of a typical pyrexia, of spots, of an enlarged spleen, and so forth should also be taken into account. Much the same may be said of *cholecystitis*, but here we have the difficulty firstly that it may complicate enteric fever, and secondly that it may in itself be the result of an attack of enteric in former days, and therefore quite possibly cause a positive Widal reaction. Other local conditions which should be remembered are pelvic cellulitis, endometritis, ulcerative colitis, diarrhoea, and constipation causing sapræmia.

It may be necessary to distinguish enteric fever from *other infectious diseases*. Typhus resembles it very closely, and the main rules for its differentiation will be found on another page (see p. 165). Influenza, again, is sometimes diagnosed as enteric fever, but its sudden onset, marked pain in the back, and frontal headache usually distinguish it sufficiently clearly. The pulse, however, is not infrequently relatively slow, although it seldom shows dicrotism, and gastrointestinal symptoms may be present. The spleen is not much enlarged. The "typhoid type" of scarlatina has been described on another page (p. 83), and should usually be recognized either by the history of rash and sore throat, or by the actual presence of characteristic desquamation. But it must be recollected that the two fevers sometimes run concurrently. Of other conditions may be mentioned cerebro-spinal meningitis, pyæmia, puerperal septicæmia, Malta fever, acute rheumatism, and malaria.

To sum up, it may be said that in many instances

clinical diagnosis will be at fault and we will have to depend upon bacteriological assistance. In all doubtful cases the Widal reaction test will give valuable information and is usually at the practitioner's disposal. In cerebral cases, where the question of meningitis arises, an examination of the spinal fluid obtained by lumbar puncture is often of the greatest assistance and is not difficult to carry out.

Laboratory Diagnosis.—Before mentioning bacteriological investigation, it will be well to describe the simple urine test known as Ehrlich's *dialzo reaction*, which has already been alluded to in connection with most of the fevers previously discussed. To perform it, two solutions are required: first, a saturated solution of sulphanilic acid in dilute (1-20) hydrochloric acid; secondly, a one-half per cent. solution of sodium nitrite. The reaction works best and most consistently if done as follows: Fill a third of an ordinary test tube with urine and add an equal bulk of the sulphanilic solution: Mix by inverting the tube, and then add one or at most two drops of nitrite, and shake up the mixture until a good froth is obtained. Now render alkaline by allowing a solution of strong ammonia to trickle gradually into the tube. The froth in a negative urine remains pale or may be coloured bright yellow. In a urine which gives the reaction, however, it becomes a beautiful rose pink, the body of the urine becoming deep crimson in colour. In a negative reaction the urine is merely dark orange or yellow, and shows no pink or crimson tints. The best guide, nevertheless, is the froth itself. It is necessary that the solutions used should be comparatively fresh. The nitrite solution in particular deteriorates rapidly and cannot be trusted after a fortnight. The common mistake made in performing the test is to add too great a quantity of this last-named solution.

A drop is quite sufficient if a tube of ordinary size is employed.

We have seen that a positive reaction is present in many fevers, and we may add here that in advanced tuberculosis its presence is nearly invariable. Miliary tuberculosis, indeed, and measles are the diseases which show it in its greatest brilliance. Its value in the diagnosis of enteric fever is limited to this, that it may be confidently expected between the fifth and twelfth days of illness, and its absence at this stage of continued pyrexia strongly suggests that some cause other than typhoid infection is responsible for the fever. Its presence at the same stage is certainly suggestive of enteric fever, but of course cannot be held to prove it. The test can easily be done by the general practitioner, and is not used sufficiently. The similar colour test, introduced by Russo, and depending on the emerald green colour caused in some typhoid urines by the addition of 3 or 4 drops of a 1-1000 solution of methylene blue is untrustworthy.

While too much reliance must not be placed upon the results of a *blood-count*, a low count, say 6000 leucocytes or under, with a high percentage of mononuclears, may be regarded as suggestive of enteric fever. It must be recollected that the presence of even a slight complication may entirely alter the characters of the enumeration, and unfortunately it is just in such complicated cases that help in diagnosis is most urgently required.

The *isolation of the bacillus* is the only certain proof of enteric fever, but if much weight is to be attached to the result it should be carried out by a skilled bacteriologist. Positive results are now obtained from *the blood* in a high percentage of cases. A large quantity of blood is required, say 5 to 10 c.c. taken from a vein,

as the bacilli occur in relatively small numbers, and it should be well diluted in sterilized bouillon, as the presence of too much blood in the medium hinders the growth of the bacilli. The dilution should be as much as from 1 in 75 to 1 in 150 parts of bouillon. If the medium becomes turbid, plate cultures are made. The bacillus may be found as early as the sixth day of the fever, and is not so readily isolated after the first fortnight. To obtain it from the *stools* it is also desirable that cultures be made early in the fever. From the *urine* it is perhaps more likely that it will not be obtained until the illness has lasted some time. Cultures from the *spots* are often successful.

The *serum reaction* test associated with the name of Widal is the most convenient for the practitioner, as it is easy to obtain a drop of blood in a capillary tube and to send it to a laboratory. The *microscopic* method most useful in side-room work is the following: Stock cultures of the bacillus typhosus are kept on agar at ordinary room temperature. From twelve to eighteen hours before the test is required a subculture is made on agar and incubated at 37° C. Within that time the culture has grown sufficiently for a loopful to be scraped off it. This is stirred into a small quantity of bouillon in a watch-glass, and it is with the emulsion of bacilli so prepared that the test is performed. The emulsion should show a uniform turbidity without lumps. Of course, if preferred, a bouillon culture may be used in preference to this emulsion, but the agar culture is more useful, as it can be used for stock purposes.

The thumb of the patient is carefully cleansed and pricked just above the nail. The blood is drawn up into an ordinary leucocytometer pipette to the mark just below the bulb. The point of the pipette is then

wiped, and sterilized beef bouillon is sucked up till the bulb is filled, after which the instrument is shaken. The pipette now contains one part of blood to ten of bouillon. The mixture is then ejected into a U-shaped tube, previously bent for the purpose in a Bunsen flame, and is centrifuged.

Assuming it is intended to subject the bacilli to the action of serum diluted to 1 in 30, one drop of the 1 in 10 diluted serum is placed on a celled slide, or on a cover-slip, and mixed rapidly with two drops of the emulsion or bouillon culture. It will be noted that the mixture contains an indefinite number of typhoid bacilli moving in a medium consisting of one part of serum in thirty parts of bouillon. The size of the drops should, of course, be roughly equal, and either judged by the eye or measured in a pipette. The preparation should be examined under an ordinary high-power lens.

If the blood be that of an enteric patient, the bacilli, at first actively motile, are seen gradually to lose their motility and tend to agglutinate into small masses or clumps. These clumps often join each other, forming larger masses, and sediment to the bottom of the cell or hanging drop. After a certain time, varying from a few minutes to several hours, the microscopic field presents several large colourless masses, consisting of agglutinated bacilli, with spaces perfectly free from moving bacilli between the clumps. Sometimes the clumps are connected with each other by long strings of motionless rods, giving a reticulate appearance to the reaction. If the blood is negative, the micro-organisms retain their motility and move actively through the field, showing no tendency to agglutinate.

If accurate results are to be expected, it is wise to see that a known negative blood and if possible a

known positive blood are examined as controls with the blood under suspicion. This prevents reliance being placed upon a culture which may have become attenuated and which is agglutinated by almost any serum. The culture used should always be under twenty-four hours old. A time limit should be imposed, and results which do not occur within one hour should be disregarded. Lastly, sufficient dilution of serum is necessary for satisfactory results. A useful dilution is 1-60, but in practice it will be found that the dilution of 1-30, as suggested above, works very well and reliably.

The *macroscopic* method, most suitable for laboratories, depends on the sedimentation of the agglutinated masses to the bottom of a small test-tube, the supernatant fluid in a positive case remaining clear, while in negative cases a uniform turbidity persists. A series of tubes, containing a standard culture of killed bacilli (the Oxford method), is treated with varying amounts of the serum to be tested so as to secure different dilutions. It is customary to test the serum with all the three bacilli of the enteric group. If preferred, emulsions of living bacilli can be used.

As to the *value of the test*, if properly carried out it will give a margin of error of about 2 per cent. When it is negative in an apparently obvious case of typhoid, it will often be found that the paratyphoid bacillus has been responsible for the infection. It must be remembered that some persons who have had the fever may continue to give the reaction for a long period of years, and that therefore positive results may be obtained from their blood when later in life they may be suffering from one of the diseases with which enteric fever is likely to be confused. The same remark applies to persons who have been vaccinated against the fever. The great defect of the test in practice is

that the reaction is often delayed and is seldom to be expected before the end of the first week. It may even be postponed till the third or fourth. To sum up, a negative result in the first fortnight does not exclude typhoid, but if this negative is still obtained in the third week the presumption is against that disease. This presumption almost amounts to certainty if no reaction is present in the fourth. A positive reaction means that the patient either has enteric fever at the moment, has had it previously, probably at a comparatively recent date, or has been inoculated.

An *ophthalmic reaction*, on the lines of Calmette's tuberculin test, has been introduced by Chantemesse.

Prognosis.—The fatality rate of enteric fever differs much in different localities and in different epidemics. A mortality of from 7 to 17 per cent. of those attacked may be regarded as a fair estimate. Prognosis is affected by *age*, the death-rate of children of under fifteen years being comparatively small. Ulcerative accidents seldom happen in the young, and one of the great causes of death is therefore not so active in their case. After fifteen years the disease is much more dangerous, and, broadly speaking, its risks increase with advancing age. As regards *sex*, women have a somewhat better chance of recovery than men, and, like children, appear to owe this to their relative immunity from hæmorrhage and perforation.

Of other general conditions affecting prognosis, fatigue and privation before infection are not to the patient's advantage, and in "ambulatory" patients who have continued working during the first two or three weeks of their illness the outlook is often serious. Stout, heavy people usually take the disease badly, and such pre-existing conditions as alcoholism and old-standing disease of the heart, lungs, or kidneys prejudice the patient's chances of recovery.

As regards the symptoms shown by the patient himself, much may be learned from his appearance and decubitus. If his face is congested or cyanosed, or if the pupils are small, he is probably seriously ill. If he cannot turn himself in bed, or still worse if he cannot remain on his side when turned, we have evidence of an amount of prostration which cannot but cause anxiety. The *pulse* is more important than the temperature in prognosis. If in adult males it exceeds 110 we are probably dealing with a bad case; should it be more than 120 there is good reason for alarm. Rapid pulses, however, in women and children need not cause much anxiety. Irregularity, suggesting as it does changes in the cardiac muscle, is a bad sign. Obliteration of the first sound of the heart on auscultation suggests cardiac weakness, and it should be remembered that this sign may be present when the pulse is not particularly bad. Prognosis is influenced by the effect of stimulants in these cases, as, if the patient responds, the outlook may yet be quite hopeful. The *temperature* is less important, and the mere presence of high fever is not a bad sign, especially if the morning remissions are satisfactory, but if it continues long at a high level with little or no remission there is always cause to dread the prostration which it entails, and again pyrexia of this kind not infrequently precedes such accidents as hæmorrhage and perforation. A sudden fall of the temperature is not to be regarded as satisfactory unless there is some improvement in the pulse and amelioration of the patient's symptoms. Too often it means the onset of an ulcerative accident. It must be thoroughly understood that the temperature should be taken and charted every four hours, or otherwise its fluctuations may be entirely missed.

Should the "typhoid state" supervene, the prognosis must be very guarded, and any exaggeration of the

nervous or ataxic symptoms is a bad sign. Mere incontinence of urine or fæces need not, however, be regarded too seriously. It seems sometimes due to sheer weakness, and may appear at a time when the patient is in all other respects improving. Even when the head symptoms in children very closely simulate meningitis, there is always hope if the spinal fluid on lumbar puncture is found to be clear and if tuberculosis can be excluded. Drowsiness at all ages is usually a good sign, and the patient who sleeps through his fever, however severe the symptoms, usually recovers.

It must be recollected that hæmorrhage and perforation are liable to occur without warning in patients who have previously caused us no anxiety. It is particularly these ulcerative conditions which make prognosis in enteric fever so uncertain. Severe diarrhœa, not yielding to appropriate dietetic treatment, is always dangerous, and meteorism if at all well marked is one of the most intractable and fatal of the manifestations of the fever. *Hæmorrhage* is seldom directly fatal, but its occurrence seems to be prejudicial to the chances of ultimate recovery. The fatality rate of patients who suffer from this complication is likely to be well over 30 per cent. It shows that deep ulceration is present and that therefore the possibilities of *perforation* are greater. Should the last-named accident occur, the sole chance for the patient is an operation, which cannot be expected to save more than one-sixth of those submitted to it. *Complications* add much to the danger of a case, and pneumonia, renal disease, and laryngitis may be specially mentioned in this connection. As regards the sequelæ of enteric fever, they rather delay recovery than cause death. The outlook in typhoid relapse is as a rule very good.

Treatment.—Although there is every reason to hope that with improved serum and vaccine treatment

we may be able to profoundly modify the course of enteric fever, the fact remains that at the present moment we are reduced to allowing the patient to fight his own battle and to putting him into as favourable a condition as possible for doing so. Fortunately the natural tendency of the disease is towards recovery, and the best attitude we can adopt in the meantime is to lay down rules for the management and diet of the patient, to let the fever run its course, and to treat accidents and complications as they arise. When the practitioner has become thoroughly familiar with the fever, he will possibly adopt one of the systems of treatment which have been suggested by various authorities.

Management.—Once the patient has been placed in suitable surroundings the first requisite is a competent nurse. It has been said that the best treatment of enteric fever is a good doctor, and there is much to be said for such a view, but in this disease of all others the nurse is of equal if not of greater importance. Once in bed, the patient must be kept strictly in the recumbent position, and the bed-pan must always be employed. The skin may be kept in good condition by the frequent use of the tepid sponge, which should be used systematically night and morning, and more frequently in severe cases. The parts exposed to pressure should be rubbed with methylated spirit twice daily, after the sponges, and in any parts which show redness a dusting powder of boracic and starch, with perhaps a little bismuth or zinc oxide added, may be freely applied. The *toilet of the mouth* is of great importance. The teeth and the inside of the mouth must be carefully cleaned at frequent intervals, either with cotton-wool swabs or a piece of soft rag. Some mildly antiseptic ointment, such as equal parts of boroglyceride and glycerine, should be applied after

each swabbing. The more water supplied to the patient for drinking purposes the more comfortable and moist will his mouth be, and to force sufficient fluids on delirious and resistive patients is one of the most important and arduous of the nurse's duties.

Another duty devolving on the nurse is to see the patient is not allowed to lie constantly on his back as long as he is able to support himself on his side. Change of position lessens the risk of bedsores and renders hypostatic congestion of the lungs less probable. The patient, therefore, will be shifted frequently from side to side, and, if necessary, supported by pillows in the desired position. The nurse will also take and chart the temperature every four hours, and will report *at once* any sudden alteration in the patient's condition, especially the sudden appearance of pain, blood in the stools, or an unexpected fall of temperature or change of pulse. She will also give every opportunity to delirious patients to pass their urine at frequent intervals.

To the medical attendant falls the duty of remembering to examine the abdomen at least once daily, to note the presence or absence of meteorism, to satisfy himself that the bladder is being properly emptied, and to keep his eye on the condition of the mouth and tongue. He should also examine the stools at frequent intervals, and especially note the presence of curds as an indication that the patient is digesting his milk imperfectly.

Diet.—The typhoid patient seems to be able to do well on either a liberal or restricted diet, but during the acute stage it is desirable to adopt the latter. While it is true that many patients have little or no ulceration and can take almost anything with impunity, it is well to "play for safety" and be somewhat rigorous as to what should be allowed. But in laying down

rules for diet it must be remembered that the patient must be treated as an individual and not as a case, and that therefore in particular instances it may be desirable to modify the rules very considerably. The success attained by various exponents both of liberal and starvation diets shows that wide deviations from the generally accepted methods of feeding are not likely to be very dangerous.

In most instances, however, it is well that the diet should be fluid, and although milk has many disadvantages it is nevertheless the most satisfactory food to give. Great care in its administration is necessary, and it should be given in definite quantities at definite intervals, each feed being regarded as a meal, and sufficient time for its digestion being allowed. In practice it will be found that for an adult three ounces of milk given every two hours will, if adequately digested, carry the patient satisfactorily through the fever, and if the presence of curds in the stools suggests that he is having more than he can manage, a very small deduction, perhaps of half an ounce from each feed, is often all that is required. The milk is best given diluted with a quarter of its own bulk of hot water, and the patient should not be allowed more than five or ten minutes to dispose of it. In this way the stomach gets a reasonable rest before the next feed is due. Many cases of difficulty in digesting milk are due to the harmful practice of allowing it to be left at the patient's bedside and permitting its use for the purpose of quenching thirst. In such circumstances undigested milk is constantly being added to partially digested milk already in the stomach, and the result is often meteorism, diarrhoea, and the presence of masses of curd in the stools. On the other hand, water should always stand at the bedside, and the patient should be encouraged to drink it frequently.

If no diarrhoea is present, beef tea in moderate amounts will be found a useful adjuvant to this limited dietary. A pint may be given in the twenty-four hours, and may be divided into three portions, the first of which, given at midday, makes a pleasant break in the monotony of the milk diet, the second in the evening often assists in inducing sleep, while the stimulant properties of the preparation may be utilized by the administration of the third in the early hours of the morning, when depression is greatest. The food value of beef tea is little or nothing, but its laxative, stimulant, and hypnotic qualities help us to avoid much unnecessary drugging of the patient.

If, on the simple diet outlined above, the patient appears to be wasting unduly fast, or if the fever is more than usually prolonged, such preparations as albumin water, egg flip, chicken jelly, or maltine may be used with advantage, and some of the patent foods, such as plasmon, somatose, or sanátogen, may be employed. Otherwise, those supplements to the diet may well be postponed till the temperature is nearly normal in the morning. There is no point in allowing more than the patient requires, and if the milk is carefully administered and well digested it is usually quite sufficient.

The great hunger complained of during the latter part of the fever is often due to a craving for salt. This may be met by salting the beef tea liberally. It is unwise to add it to the milk, as it is highly important not to disgust the patient with what remains his staple food. When the morning temperature has been once or twice normal, such additions as boiled bread-and-milk or thin oat-flour porridge may be permitted, and many patients will take fish quite well before the evening temperature has become steadily normal. The fish should be steamed, all skin being

removed, and supplied at first in very small portions with thin fingers of bread without crust. Should the morning temperature rise above normal, it is well to return to the fluid diet at once. If, however, the fish is well tolerated, it may be increased in quantity, and in three or four days chicken may be quite safely given. A small amount of mashed potato is usually digested quite well.

As regards *drinks* throughout the illness, the importance of supplying plenty of water has already been emphasized. About six pints in the twenty-four hours is a satisfactory quantity, and a good nurse will usually succeed in getting this amount taken. The free supply of fluid exerts a very beneficial action on the toxæmia, and the forced ingestion of large quantities of water is nowadays one of the systematic methods of treating enteric fever. Elimination of toxins is favoured by the polyuria which is caused by this method, and as a result many of the worst nervous manifestations of the disease are favourably modified. Aerated waters should not be allowed, as they tend to encourage meteorism. There is no objection to tea in moderation, and the average patient enjoys a cup in the afternoon. Cocoa may be useful in assisting patients to take milk if they dislike the latter, and the same may be said of coffee if there is no tendency to insomnia.

Diet Modifications.—Should diarrhœa be troublesome, beef tea or any similar preparation should be at once withheld. The milk should be boiled and somewhat reduced in quantity, and it is sometimes useful to dilute it with limewater instead of water. When there is much prostration, bovine or raw meat juice may be given, and jellies are usually safe. If the patient, on the other hand, suffers from constipation, the addition of fluid magnesia to the milk is of

advantage. For meteorism, reduction of the quantity of milk allowed, and peptonizing it, will often be found of service. The same treatment may be applied in cases of persistent vomiting, and in all the above conditions it is advisable to remember that the typhoid patient tolerates starvation very well, and that it is better to give too little than too much. This is particularly true of patients after hæmorrhage, and, should that accident happen, nothing need be given for thirty-six to forty-eight hours, except perhaps sips of water or a little ice to suck. Thereafter very small quantities of nourishment, such as half-teaspoonfuls of bovine in water, and a tablespoonful of milk every four hours, will be often sufficient for another two days. In convalescence, unless the resulting fever is enough to weaken digestion, such conditions as thrombosis, periostitis, and so forth, are the better for liberal feeding.

General Treatment.—Provided that the patient is suitably nursed and dieted, the illness may be allowed to run its course, the medical attendant being content to treat symptoms as they arise. It will be sufficient, then, to mention some of the more important of the conditions which may possibly require to be dealt with, and to indicate briefly the lines on which they may be treated. It will, as a rule, be quite unnecessary to interfere with the *temperature*. The patient can, if desired, be sponged more frequently, and cold, or even iced, water may be employed for this purpose if the pyrexia appears excessive. But the use of anti-pyretic drugs, which are still far too frequently employed in general practice, is much to be deprecated. In the early days of the fever *headache* is sometimes troublesome. It is often relieved by the application of cloths dipped in vinegar or in iced water to the head, and a 5 gr. dose of citrate of

caffeine is occasionally of service. For *insomnia*, if such measures as the use of cool sponges and the administration of hot drinks fail to induce sleep, perhaps the most satisfactory drugs to use are bromide of sodium and chloral hydrate in equal parts. Twenty grains of each may be given, and followed up if necessary by half the amount at half-hourly intervals until sleep is secured, the pulse, of course, being carefully watched. Occasionally, when sleeplessness seems to depend upon worry and anxiety, a 5 gr. Dover's powder is an excellent prescription, which will also be found of value when the patient is kept awake by slight diarrhoea disturbing him at frequent intervals. For *diarrhoea* itself, we have seen that dietetic modifications are often sufficient treatment. Sometimes, however, an antiseptic drug such as guaiacol carbonate or naphthol may be prescribed with advantage, and it is always worth while to irrigate the large intestine with hot water once or twice daily. If *constipation* is present, drachm doses of castor oil or simple enemata give satisfactory results. For *meteorism*, enemata may also be used, and turpentine should be administered in 20-drop doses every two or four hours. Turpentine stupes may also be applied externally.

In *hæmorrhage* the chief object should be to allow its natural arrest by immobilizing the bowel. This can be to some extent effected by starvation, as indicated above, and also by the administration of opium. Some authorities object to the latter on the ground that it masks the symptoms should the case proceed to perforation, but as the latter accident only occurs in 10 per cent. of cases of hæmorrhage and that usually at a later period in the fever, in the presence of a large bleeding no hesitation as to its use is necessary. It has the advantage, moreover, of assisting the patient to tolerate the restriction of his

diet and fluids. Other drugs which may be given are calcium chloride or turpentine, both of which are recommended. The bowels should not be allowed to move for about four days, after which an olive-oil enema may be given. After very profuse hæmorrhages it may be necessary to stimulate cautiously, but the greatest care must be taken not to improve the circulation too much.

When a diagnosis of *perforation* is made, the patient, if not moribund, should be operated on at once. The abdomen is opened and the perforation inverted and stitched up. If operation is deemed impossible, all that can be done is to give opium freely in the hope of allowing adhesions to shut off the leaking point from the rest of the peritoneal cavity.

Complications and sequelæ must be treated on the usual lines.

As regards *stimulation*, it is a mistake to suppose that every patient requires alcohol as a routine. On the contrary, by far the greater number will get through their fever quite satisfactorily without it. When the pulse in an adult exceeds 120 per minute, and the first sound of the heart is almost inaudible, it is often of value, as is also the case with patients who have much pulmonary congestion. But its effect should be carefully watched, and unless it brings the pulse nearer to the normal it is probably doing more harm than good. Some patients become restless and excited after the administration of alcohol, and others, again, suffer from perspiration. In such alcohol should be discontinued, and in all cases Jenner's rule, "If in doubt about stimulating, don't," is well worth remembering. An occasional dose of alcohol, however, may be useful in special circumstances, as for instance after the bath, if the bathing system is employed, or to assist in the production of sleep. Whisky is pro-

bably the most satisfactory form in which alcohol can be administered. The dose should always be small at first, one or two drachms every four hours, and need seldom be increased beyond the half-ounce. If diarrhœa or sickness is present, brandy will be found more useful. In convalescence port wine or stout may be given to adults with great advantage.

It may be said broadly that drugs are inferior to alcohol in their effect on the heart in this fever. Digitalis and strophanthus are disappointing. Strychnine may be useful on occasion, but is contra-indicated if diarrhœa or restlessness is present. It should be remembered that strong beef-tea judiciously administered will often prevent or postpone the necessity for other stimulants.

Systems of Treatment.—It will be unnecessary in a manual of this character to say much regarding the various systematic methods of treatment. A few, however, may be briefly noted, as they indicate different lines on which the fever may be dealt with. The first and most important is unquestionably treatment by the *cold bath*, introduced by Brand of Stettin in 1861, and still very popular in America and on the Continent. It was devised as an antipyretic treatment, and the indication for the bath is a temperature of 102.2° F. in the rectum. It owes its success, however, not to the diminution in the pyrexia, which is often of a very temporary character, but to the increased elimination of toxin which is effected by the diuresis which it sets up. The baths are given at a temperature of 65° F., and compresses dipped in iced water are laid upon the chest and the abdomen. The patient remains fifteen minutes in the bath, and is systematically rubbed down by the attendants. In some cases the effect is so transient that several baths may be given in twenty-four hours. The main contra-indications are hæmorrhage,

peritonitis, and phlebitis. The treatment is inconvenient to carry out, and as increased elimination of toxin can be secured by simpler methods, and the effect of the treatment on the tone of the skin to some extent imitated by the use of cold sponges, it has never been much used in this country. The cold bath as an occasional measure may, on the other hand, be employed advantageously in cases suffering from severe toxæmia.

Another systematic treatment, the *antiseptic*, was at one time much used, but it soon became obvious that it is impossible to adequately disinfect the bowel by the use of internal remedies. But the general practitioner will often find it desirable, if not actually necessary, to prescribe some drug treatment, and in such circumstances he cannot do better than give either naphthol β , 6 grains every four hours, guaiacol carbonate in similar amount, or cinnamon oil in 3 to 5 minim doses. All these drugs favourably affect such conditions as meteorism and diarrhœa, tend to deodorize the stools, and may be trusted not to harm the patient. But they do not cut short the fever, nor can they be depended upon to limit ulceration.

Some of us in treating enteric fever propose as our ideal the *clean bowel*, that is to say believing that undigested food substances and fæcal matter allowed to lie in the intestine encourage the process of ulceration, we endeavour by a special diet or other means to secure that there should be no stagnation. A diet such as suggested by Ewart, consisting of whey instead of milk, and supplemented by maltine or honey, can be reasonably expected to leave little or no residuum. At the Edinburgh City Hospital the custom is to give a dose of 3 grains of calomel every second day to empty the small intestine, and to wash out the large gut with an irrigation of about 4 pints of hot water from

a douche-can. The irrigation is administered about six to seven hours after the calomel, and besides keeping the large bowel clean prevents any pain or griping from the drug.

Recently the systematic *forced ingestion of water* has been much employed. We have seen that it is wise to give about 6 pints daily if possible, but this amount can be much increased if the nurse is patient and takes sufficient trouble. Such large quantities as from 12 to 14 pints are successfully given in some American hospitals, and the effect of the increased elimination of toxin on the toxic manifestations of the disease is very considerable. Headache, delirium, insomnia, and subsultus are all diminished when this method is used.

Serum and Vaccine Treatment.—There is as yet no reliable *serum* treatment for enteric fever. Most of the preparations which have been used are bactericidal and possess no antitoxic action. The isolation of the endotoxin of the typhoid bacillus is extremely difficult, and the preparation of an antitoxin, therefore, is not the comparatively simple matter it is in diphtheria. Chantemesse has, however, prepared a serum which appears to have given excellent results, and Hewlett by the injection of typhoid cell-juice into horses has produced an anti-endotoxin which seems to favourably influence the course of the fever. The prospects of serum treatment are nevertheless not very good. Judging from our experience of antidiphtheritic and anti-meningococcal serums, early administration is necessary for the success of antitoxin treatment, and it is unusual for typhoid patients to come under observation early enough to give serum a fair chance.

More may be hoped from the employment of *vaccines*. If employed, an autogenous vaccine, that is one prepared from the patient's own bacilli, may be

preferred, but stock vaccines appear to be quite satisfactory. There is much difference of opinion regarding *dosage*, but from 200 to 500 million bacteria for a first dose, followed by larger amounts, may be regarded as suitable. Some advise more liberal doses—from 1000 to 2000 millions. The *interval* between the injections should be three days, and if this time is much exceeded some authorities advise a reduction, instead of the usual increase, of the dose. Slight local reaction and occasionally some exacerbation of the temperature may follow the injection, which is made subcutaneously.

Although most of the observers who have used vaccines speak enthusiastically of the results, their value cannot as yet be regarded as conclusively proved. It is stated that sensitized vaccines are the most effective.

Remarkable results have been obtained by the intravenous injection of vaccines, whether sensitized or otherwise. In this case, however, the effects seem to depend mainly on the shock and subsequent leucocytosis which is caused by the introduction of a foreign protein. The treatment does not appear to be free from risk, but causes the abortion of the illness in a considerable percentage of cases. It is not specific, as good results have been obtained by the injection of bacteria other than those of enteric fever. The method indeed is one of "protein shock therapy" rather than of vaccination, and the reaction is analogous to that which is produced by the intravenous injection of the colloidal metals, also used for the treatment of this fever.

Management in Convalescence.—We have already followed the changes in diet which may be made in the first few days of normal temperature. The typhoid convalescent is usually left somewhat exhausted by his attack, and it is well to encourage him to keep in the

recumbent position for some days. There is always a risk, if slight, of cardiac failure supervening, and cases of sudden death have been reported at this stage. The average patient, however, may after four or five days of absolutely normal temperature be raised on pillows, and by the tenth day is in most cases able to be out of bed for half an hour. Constipation, frequently noted at this period, may be treated by one drachm and a half doses of castor oil, or by moderate amounts of fluid magnesia. Patients who suffer from sequelæ must, of course, be kept in bed. It is wise to keep the patient in hospital for at least four weeks after his fever is over, and in many cases the detention may have to be very much longer. Most adults are not fit for work till at least three months have elapsed from their first symptom. In some hospitals urotropine is systematically administered in convalescence to clear the urine of bacilli, and the stools and urine are both subjected to bacteriological examination before the patient is discharged. This is doubtless desirable when it can be done, but it must be remembered that "carriers" do not continually excrete micro-organisms and that negative results are therefore no certificate of safety.

Prophylaxis.—Compulsory notification of the actual cases is, of course, necessary. The prevention of epidemics will depend upon the supervision of the water supply, the inspection of dairies, and the control of the collection and sale of shell-fish. In outbreaks recurring in a particular house or institution the existence of a possible "carrier" should be suspected, and an examination made of the stools and urine of any inmate who has had the fever at a previous date, particularly if he or she is concerned in the preparation or distribution of food. It is well to have the drains examined, as although they play little part in the production of outbreaks, it is conceivable that a leak,

by contaminating the surrounding soil, might cause infection by dust or pollute water.

As regards the prevention of infection from an existing case, it is to-day customary to send a large proportion of patients to a fever hospital. If, however, an individual is nursed at home, great care must be taken to see that the excreta are properly disposed of. They should be mixed with their own bulk or more of 1-20 carbolic acid and allowed to stand for an hour or longer before being emptied down the drains. The bed-pans should be carefully covered, and care taken to prevent flies settling on either fæces or urine. Soiled sheets should be rapidly rolled up and placed in a bucket at the bedside and damped in carbolic solution at once. They should then be wrung out of the anti-septic and, fæcal stains having been brushed out, left to soak in 1-40 carbolic acid for six to twelve hours before going to the laundry. In spite of such precautions, nurses take enteric fever with comparative frequency. They should take great care in cleansing their hands after touching the patient and before their meals. In some hospitals they are encouraged to use rubber gloves.

Typhoid Inoculation.—Prophylactic vaccination was introduced by Wright in 1897, and its value is now generally admitted. Different methods are used to prepare the antigen, which may be living, killed by heat, or sensitized. The British Army vaccine is a culture attenuated at a low temperature (53° C.), and then finally killed with lysol. The vaccines usually contain 1000 millions of bacteria per c.c., and two doses of 1 and 2 c.c. respectively may be given with an interval of about ten days. The efficiency of the protection conferred is said to depend more on the number of the bacilli injected than upon the number of doses given.

The first year of the war showed that antityphoid inoculation alone was not a sufficient protection, and a vaccine against not only the typhoid, but also the two paratyphoid, organisms, the so-called T.A.B. vaccine, was therefore adopted. This multiple preparation seems to be tolerated as well as the simple one.

The vaccine should be injected subcutaneously in either the subclavicular or deltoid regions. The reaction is seldom severe. There is some local swelling, and a certain proportion of cases have general fever, headache, and malaise. Inoculation should be postponed if the patient is fatigued or ill, and is contra-indicated in cases of severe organic disease, tuberculosis, arteriosclerosis, diabetes, and renal insufficiency. Allowance should be made for at least twenty-four hours' complete rest after the injection.

Troops proceeding on active service should always be inoculated, as should civilians leaving for India and other countries where the fever is endemic. In epidemics in this country it may become advisable to vaccinate extensively. The prejudice against inoculation in the presence of infection seems to have been overcome, and there is little reason to fear causing susceptibility during the "negative phase." In any case, an almost immediate protection is said to be procured if a sensitized vaccine is employed.

Inoculation confers *immunity* for probably two years. Should the fever be contracted it is likely to be much milder. Both the death rate and the complication rate are much lower in the inoculated than in the uninoculated.

CHAPTER XI.

DIPHTHERIA.

Bacteriology.	Diagnosis.
Pathology.	Differential Diagnosis.
Infection and Dissemination.	Bacteriological Diagnosis.
Period of Incubation.	Prognosis.
Symptoms and Course.	Treatment.
Types of Faucial Diphtheria.	Serum Treatment.
Laryngeal Diphtheria.	Serum Sickness.
Nasal Diphtheria.	Local Treatment.
Diphtheria in Other Situations.	Treatment of Heart Failure and Paralysis.
The Heart and Circulatory Failure in Diphtheria.	Treatment of Laryngeal Diphtheria.
Post-Diphtheritic Paralysis.	Treatment of Carriers.
Complications.	Isolation and Quarantine.
Relapses and Second Attacks.	Prophylaxis and Immunity.

Bacteriology.—Diphtheria is due to the bacillus first described by Klebs in 1883, and successfully cultivated and further investigated by Löffler in the following year. It is a slender rod, either straight or slightly curved, and usually about $3\ \mu$ in length. There are, however, short, long, and intermediate forms. It stains readily with basic aniline dyes, and usually presents a beaded or dotted appearance, although in some instances the staining is uniform. In diphtheritic membrane it may be found in clusters or irregularly scattered. It grows well on solidified blood serum at body temperature, presenting in about twelve hours small circular colonies of whitish colour. Involution forms appear in old cultures, and club-shaped and barred rods are occasionally met with. The bacilli can live for long periods in dry membrane, but are readily

killed by an exposure to 60° C. In beef bouillon they give off *toxins*, as is proved by the fact that, if the fluid is cleared of bacilli by filtration, the filtrate is capable, even in minute doses, of causing the death of small animals, such as guinea-pigs and rabbits. This filtrate is usually spoken of as diphtheria toxin, and contains a variety of poisonous substances, one of which appears to be responsible for the local œdema which follows inoculation, another for the symptoms of toxæmia, and a third for the late effects on the nervous system as manifested by paralysis.

Pathology.—The bacillus having effected a lodgment in some microscopic breach of the mucous membrane, causes locally the fibrinous exudation which is characteristic of the disease. There is degeneration, necrosis, and desquamation of the superficial epithelial cells, and the process continuing with much exudation of fibrin, the *false membrane* is formed and increases in thickness. Microscopically it consists of a network of fibrin containing red blood cells, epithelial débris, and here and there clumps of bacilli. Some pyogenic cocci are usually also present. From the original situation bacilli are carried by the blood and lymph streams to various organs, and have been found in the spleen, liver, kidney, and heart's blood. They are also frequently found in the lungs, a situation which they may reach by direct extension downwards of the original lesion or by inhalation. The patient may also infect other parts of the body, the genitals for instance, with the fingers.

The toxins are absorbed into the blood and lymph from the local lesions, and have marked effects upon the heart, the kidneys, and the nervous system. The heart suffers severely from the first in a severe case of diphtheria, and its muscle is rapidly affected by fatty degeneration. The kidneys of fatal cases always show

degenerative change, and hæmorrhages have been observed in the substance of the suprarenal bodies. The peripheral nerves undergo a degeneration of the medullary sheath, which is broken up into globules. The cylinders may be broken across. Both sensory and motor fibres may be affected, but the process is usually a limited one, and the resulting paralysis is therefore only partial. Changes in the cells of the anterior cornua of the spinal cord have been observed, and it is possible that the nerve degeneration may be secondary to these.

Infection and Dissemination.—The disease may occur in all climates. As regards *season*, it is less common in the summer than in the winter months. *Sex* exerts no influence for the first ten years of life, but thereafter females appear to show a greater susceptibility than males. *Age* is, however, a question of more importance. Diphtheria is essentially a disease of the first ten years of life, and especially of the first five years of life. Infants often escape, but in the second year the disease is very common. After the age of ten years liability seems to decrease with increasing age.

Infection, whether derived from a patient or carrier, occurs by *contact*, such as by kissing and so forth, or by the coughing or sneezing of infectious particles on persons in the immediate vicinity. Another very usual method, however, is by the common use of penholders, slate pencils, towels and handkerchiefs in the home, and more particularly in the schools. The bacillus may remain active in fomites for a considerable time, and it is easy to see how in a school one individual harbouring bacilli in the throat is capable of causing much infection. *Schools*, indeed, play a very prominent part in the production of diphtheria outbreaks.

The bacillus can also be carried by *milk*, which may readily become infected if a person with unrecognized diphtheria is employed in the dairy. As to *defective*

drains, their influence is in all probability a predisposing one, that is to say, the relaxed throats which they encourage form an excellent nidus for any diphtheria bacillus which may be present. All conditions which cause catarrhal inflammations of the fauces or larynx predispose to diphtheria, and this is well illustrated by the liability of scarlet fever and measles convalescents to the disease. It is certain that a healthy mucous membrane is capable of resisting diphtheria, and many persons in perfect health harbour the bacillus in the throat. Such individuals, termed *carriers*, are, however, capable of infecting others who have less resistance or whose fauces from some temporary cause are in a more receptive condition. A "carrier" may occasionally be a convalescent from the disease itself, but in the majority of instances has picked up the germ without himself becoming infected. There is every reason to believe that the dissemination of diphtheria is largely due to this particular class, which has been found responsible for many school outbreaks.

Some *domestic animals* have been accused of spreading diphtheria, but the evidence against them is very inconclusive.

Period of Incubation.—This may be roughly estimated at from two or three days to a week. In certain instances, however, the disease seems capable of developing within twenty-four hours. On the other hand, it is probable that, as bacilli may exist in the healthy throat for an unlimited time, actual infection may not in some instances take place until some simple throat inflammation or other predisposing condition favours its occurrence. In such circumstances an individual may not develop the disease until long after exposure, and it is possible that certain cases of diphtheria occurring in the convalescence of scarlet fever and measles may be in this way explained,

Symptoms and Course.—Diphtheria may attack various parts of the body. While its most common sites are undoubtedly the fauces, nasopharynx, and larynx, it is not uncommonly seen on the genital organs, and it may also affect the conjunctiva, the anus, the surface of a wound, or even the skin itself. In most of these situations the process is the same, and is characterized locally by the formation of a false membrane. For general purposes of description we may limit ourselves to diphtheria, as it affects the fauces and neighbouring parts.

Symptoms of Invasion.—The stage of invasion may be described as very short, the appearance of definite patching on the throat seldom being long deferred. Fever is probably the earliest sign. It is not very severe, and varies from 100° to 103° in the majority of cases. Headache, malaise, and chilliness may be noticed, and vomiting is fairly common, although less frequent than in scarlatina. The pulse is soft and rapid from the first. Sore throat is usually but not invariably complained of.

The throat and its appearances. The first stage in the development of a diphtheritic lesion is congestion of the mucous membrane, but some spotting or patching is usually visible as soon as it is looked for. The commonest *situation* is unquestionably the tonsil, and often both tonsils are affected from the first. But the exudation may make its first appearance on the uvula or the pillars of the fauces. In its early stage this exudation hardly deserves the name of false membrane. It is merely a thin pellicle and can often be wiped off. If removed, however, it rapidly reappears, and it quickly becomes consistent and more securely attached to the underlying tissues. Within twenty-four hours it has assumed the characters of a "false membrane" and tends to spread rapidly over the

surrounding structures. In *colour* it varies considerably, but is usually somewhat grey. It must be remembered, however, that white or pale yellow membranes are frequently observed. The false membrane is firmly adherent to the subjacent mucous membrane and can only be detached with difficulty, leaving a bleeding surface behind it. After some days, however, when its natural separation is to be expected, it can occasionally be wiped off without causing hæmorrhage. When removed it is tough and consistent, can be floated out in water, and will stand considerable pulling about without tearing, contrasting in these particulars with the pultaceous or cheesy material which is seen in some forms of septic sore throat. When the membrane is spreading it is surrounded by an area of deep congestion which shows itself as a narrow red margin round the edges of the lesion. The *extent* of the membrane varies much even in untreated cases. Sometimes it limits itself to the tonsils; in other cases it involves the pillars of the fauces, the palate, the uvula, and more rarely the posterior pharyngeal wall. The spread to these situations may be extremely rapid, sometimes taking place within thirty-six hours. The membrane is not always continuous, but often starts on both tonsils at once, and spreads more or less extensively on either side. Sometimes the process starts in the crypts of the tonsils, and at first presents a spotted appearance resembling that of follicular tonsillitis. If untreated, however, this is apt to blend into a homogeneous membrane in a few hours.

The unaffected parts of the throat are often comparatively pale, and this is especially true of the soft palate. If there is much associated septic infection, there may be general *œdema* and redness, but the diphtheritic process itself is not necessarily attended by these manifestations, and is therefore relatively painless

when compared with other throat inflammations. Very often sore throat is not complained of at all, and swallowing is so easily accomplished that even careful parents do not suspect that there is anything amiss with a child's throat. On the other hand, septic infection often accompanies diphtheria, and in such cases both pain and swelling may be well marked. There is usually an unpleasant *odour* from a diphtheritic throat, and this in severe cases may be exceedingly putrid.

When antitoxic serum has not been employed, the membrane spreads until the natural tendency to cure asserts itself. In some cases the spread is very limited ; in others the nasopharynx and larynx may be involved and the whole soft palate covered before limitation occurs. The ultimate tendency of the membrane is to separate, and separation may be complete long before the patient succumbs. Often large pieces of membrane become detached. In serum-treated cases the membrane is more likely to be gradually disintegrated and come away in shreds. The subjacent mucous membrane remains slightly greyish in colour for a short time after the disappearance of the membrane.

The glands. The enlargement of glands usually noticed in diphtheria is due rather to the toxins than to the bacillus itself. The glands most frequently affected are the submaxillary, those at the angle of the jaw, and the anterior cervical group. The enlargement is often very slight, and all that may be noticed is a little tenderness. In very toxic or septic cases, on the other hand, the swollen glands form a collar round the throat. Suppuration is unusual and only to be expected if there is much septic infection.

The temperature. While some pyrexia is usual for the first two or three days of the illness, it does not show any characteristic curve and is very variable in amount. It usually subsides before the throat is clean ;

indeed, the tendency of diphtheritic toxæmia is rather to depress temperature than to elevate it (see Chart). Some cases run their whole course without pyrexia, and the temperature elevation is in no way proportionate to

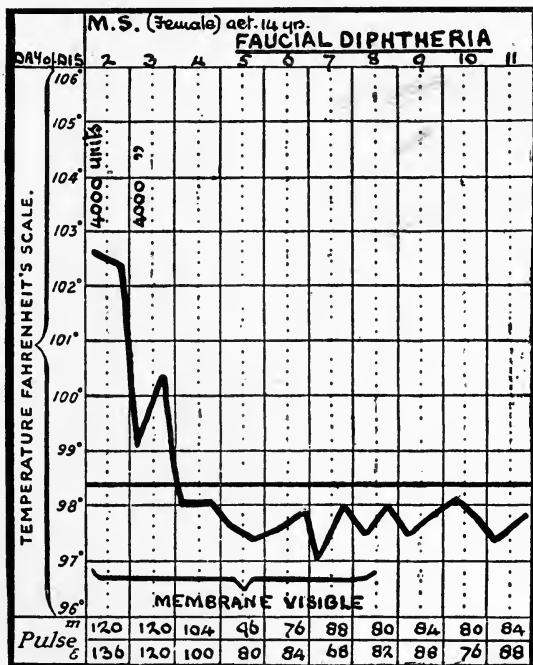


FIG. 12.—Diphtheria. Showing well-marked fever at onset and subnormal temperature thereafter.

the severity of the local lesion. On the contrary, in pure diphtheritic infection low and even subnormal temperatures are common. On the other hand, the temperature may remain elevated if there is much superadded septic infection. The *pulse* during the early days of the disease is soft and more rapid than the pyrexia warrants. Later it tends to be slow, particularly in

adults. After the first week of illness the effect of the toxæmia on the circulation becomes more apparent. It is discussed on a subsequent page (see p. 242).

General Symptoms.—During the first few days the face is sometimes flushed, but, if the attack is at all severe, pallor is an early symptom. The expression is apathetic, and lassitude, if not prostration, is usually noticed from the first. Some patients who are suffering severely from toxæmia are extremely drowsy, and may have to be roused for their nourishment. *Albuminuria* is a frequent symptom, but a true nephritis is rare, the presence of the albumin being due to the effect of the toxins upon the kidney. It varies in amount from a faint trace to very considerable quantities. It is apt to appear first in the urine from the fourth to the tenth day of illness. Albuminuria is very seldom persistent. The amount of urine is often much reduced, and occasionally in fatal cases there is absolute anuria for about two days before death. In rare instances, *erythematous rashes*, not to be confused with those caused by serum, occur in the early days of the disease. They are roughly scarlatinal in character, but do not show very definite punctation and are irregular in their distribution.

The throat lesion has with serum treatment usually cleared up within a week, though in some instances the membrane may be visible for some days longer. The temperature remains normal or subnormal, and except for some irregularity or softness of the pulse and the presence of albumin in the urine, it might be assumed that the patient is on the highway to recovery. Unfortunately in many cases diphtheria begins to be most interesting and dangerous after the first week is over, and it is not unusual for death to result from paralysis or heart failure after several weeks of normal temperature.

Types of Faucial Diphtheria.—These may be classed as *mild*, moderate, and severe. Under the first heading fall those slight throat inflammations which are associated with and probably due to the diphtheria bacillus, but which do not present characteristic membrane, and can hardly be regarded as clinical diphtheria. Some, indeed, may be merely instances of simple sore throat affecting a "carrier" of the bacillus. The *moderate* type is the most usual, and under it may be classed those cases which present definite membrane limited to the fauces and which do not show much toxæmia. It must be remembered, however, that although patients suffering from this type of the disease may show rapid and gratifying improvement from the first, they are still liable to paralytic sequelæ which may be in themselves dangerous, and also, unless great care is taken of them, to cardiac failure in convalescence. As to *severe* types, cases presenting involvement of the nasopharynx in addition to faucial lesions, or in which there is also marked septic infection, may be said to fall into this class. There is nasal discharge, and often excessive glandular swelling, and albumin appears early in the urine and is often in considerable quantity. The pulse is weak from the first, and becomes unduly fast or slow before the local condition has cleared up. The prostration is extreme. Such patients may make good recoveries, but are very liable to paralysis and late heart weakness, and too often gradually sink from the first, death occurring about a week or ten days from the onset of the disease. Another severe type is the *toxic* or hæmorrhagic form of diphtheria, characterized in addition to the features just noted by waxy pallor of the face, excessive oozing of blood from the throat and nose, and definite purpuric spots upon the skin. Bruising occurs readily both at the

site of the serum injections and on the arms and legs if the patient has required to be held firmly during the administration of antitoxin. Conjunctival and other hæmorrhages are also noticed, but hæmaturia is rare. This type of the disease is invariably fatal.

Laryngeal Diphtheria.—Diphtheria may affect the larynx primarily, or it may spread to that situation from the pharynx. In a certain proportion of cases the membrane is limited to the larynx itself, but it may spread upwards or downwards. If the latter, it may reach the lungs, lining the trachea and bronchial tubes. The symptoms presented by a case in which the larynx is implicated are those of what is popularly known as "croup," and may be briefly summed up as aphonia, a metallic cough, and dyspnœa.

If untreated, the condition will probably pass through the following stages. In the first or *initial stage* the patient presents the signs of a simple laryngitis, suffering merely from hoarseness or actual aphonia, a croupy cough, and slightly accelerated respiration, accompanied by moderate fever. After a varying time, sometimes only a few hours, the second or *spasmodic stage* is entered upon, and there are recurrent attacks of dyspnœa. The breathing suddenly becomes laboured and noisy, the face congested, and the extraordinary muscles of respiration are called into action. The child alters his position constantly, often trying to sit up. The difficulty in breathing is increased by frequent attacks of coughing, during which cyanosis may be extreme. If the chest is inspected during one of these spasmodic attacks, it will be noticed that on inspiration the soft parts of the chest instead of being pushed out are drawn in, the obstruction at the glottis preventing the adequate filling of the thorax. This *recession* of the soft parts is noticed particularly in the intercostal spaces and epigastrium.

The paroxysms are at first brief, and the patient may obtain relief after coughing up quantities of mucus and occasionally shreds of membrane. Often he falls asleep only to be awakened after a longer or shorter interval by another paroxysm. These accesses of suffocation appear to depend largely on spasm of the glottis, though occasionally they are due to loosening membrane in that situation. The interval between them tends to become shorter, and the relief obtained by their cessation gets gradually less. Instead of sleeping, the patient shows great restlessness, and suffers considerably from increasing dyspnœa between the actual spasms. The third stage, that of *permanent obstruction*, is now reached. The dyspnœa is constant, and the patient remains cyanosed. The heart begins to fail, and the pulse becomes small, irregular, and extremely rapid. The strength of the respiratory efforts diminishes, and as a result recession, though permanently present, is often not so well marked as in the spasmodic stage. The face is pale, the lips purple, and the restlessness is less marked, the patient being too prostrate to struggle. If operation is not performed, death is the natural sequel. All patients do not necessarily reach this stage, death supervening in the spasmodic period as the result of plugging of the glottis with a detached piece of membrane or some similar cause.

Should the *trachea* alone be affected by the diphtheritic process, aphonia is not present and the cough not typically croupy. The obstructive symptoms are well developed, and are constant rather than spasmodic. The smaller bronchi are frequently involved, and diphtheritic broncho-pneumonia often follows.

Unless the fauces and nose are implicated as well as the respiratory passages, the amount of general

toxæmia is usually slight, and provided the case is adequately treated with serum, and operation if necessary performed, paralytic and cardiac sequelæ are rare. Once the danger of suffocation is over, convalescence is usually uninterrupted, unless indeed broncho-pneumonia has supervened. In most respiratory cases there is some fever, and once the temperature has fallen and the respirations become normal in rate, the outlook is generally good. The larynx and trachea seem incapable of absorbing diphtheritic toxin to the same dangerous extent as do the throat and nose. Should the latter, however, also be affected, the patient has the same risks in convalescence as an ordinary case.

Nasal Diphtheria.—When associated with faucial lesions, diphtheria affecting the nasal passages is a most fatal type of the disease. A clear discharge first appears from the nostrils, and soon becomes sanguineous or purulent. It is irritating in its character, and is apt to excoriate the nasal orifice. Membrane is sometimes visible in the anterior nares. There is much toxæmia, often early heart failure, and a high percentage of the cases subsequently develop paralysis. Diphtheria, on the other hand, may be limited to the nasal passages. On the whole, this type is not likely to be so severe as when the throat is also implicated, but in certain instances there is considerable glandular enlargement and marked toxæmia with all its possible effects. In other cases, however, there may be much membrane in the nose and yet little or no constitutional disturbance. It is not unusual for the local condition to be very persistent, or indeed chronic, as in the so-called *fibrinous rhinitis*. Lastly and very commonly, the diphtheria bacillus is responsible for purulent discharge from the nostrils with no membrane formation and no constitutional symptoms. It is

wiser to regard patients who suffer from this form of rhinorrhœa merely as "carriers" and not as true examples of the disease. They doubtless, however, play no small part in its dissemination both in schools and hospitals. It will be seen, then, that the bacillus when it effects a lodgment in the nose is capable of causing either the most severe or the most trivial forms of diphtheritic infection.

Diphtheria in Other Situations.—In other situations than those above named the infection is more likely to be secondary than primary, and to be communicated by scratching, or in some similar manner, with fingers contaminated with the discharge of nasal or throat lesions already existing. The *vulva*, for instance, is extremely likely to be infected in this way, and the same may happen, though more rarely, to the *prepuce*. More rarely still, the *anus* may be the site of a secondary infection. In all these instances there is membrane formation and a purulent discharge containing bacilli, and vulvar infections in particular are often severe and followed by much toxæmia. The *conjunctiva* may also be infected, often directly from the nose, and a thin, not very firmly adherent, membrane appears on the inner surface of the lids. The bacillus is also capable of producing an interstitial inflammation of the surface of the eye itself, and this may result in sloughing of the cornea and permanent loss of sight.

Besides the ordinary faucial lesions, membrane is occasionally observed on the *buccal* mucous membrane, on the *lips*, and on the *tongue*. These lesions are persistent, and are often due to mixed infection. Another unusual situation is the external auditory meatus. Some eczematous eruptions, usually impetiginous in character, appear to be due to infection by the diphtheria bacillus.

Diphtheria can also affect *wounds*. An abraded surface is inoculated, and may become covered with membrane or merely present an unhealthy sloughing surface. The true cause of such conditions is often unsuspected until typical post-diphtheritic paralysis supervenes. Wound diphtheria is sometimes primary, but more often secondary to lesions in the throat or elsewhere. A circumcision wound seems to lend itself particularly to secondary infection.

The Heart and Circulation in Diphtheria.—In every case of diphtheria there is the possibility of circulatory trouble arising, and from the first the *pulse* must be carefully watched. In bad cases it may cause alarm from the onset of the disease, but even in moderate cases it is apt to show some irregularity in the second week. It is often very soft, and in rate may be either unduly fast or unduly slow, the last feature being more commonly noted in adolescents and adults. Irregularity both in the strength and rhythm of the wave is often observed, and occasionally there is intermission. Endocarditis is rare. On auscultation soft systolic murmurs are not uncommon, and in severe cases the second sound is often reduplicated. The blood pressure is low.

Circulatory failure has been attributed to a variety of causes. It has been regarded as a *paralysis* due to damage to the innervation of the heart, and it may be assumed that in some cases at least the degeneration not infrequently observed in the vagus has been responsible for the fatal termination. The *myocardium*, however, is also much damaged by the toxæmia, and until quite recently the failure of the circulation was more generally considered due to this cause. The fact, on the other hand, that in many instances the pulse becomes progressively worse while the heart sounds remain regular and distinct has led to the

suggestion that the failure is primarily vascular and is not improbably the result of *adrenal insufficiency*. According to the latest view the condition may be explained by a diminution in the quantity of the circulating blood, which may be "distributive" and due to stasis in some part of the venous circulation, as in shock, or "quantitative" and depending upon loss through the vessel walls owing to their permeability having been increased by the direct action of the toxin. That the latter type is often present is suggested by the high specific gravity of the blood and the slight œdema, or so-called "lymph-logging" of the tissues. This condition of *oligæmia*, then, taken in conjunction with myocardial weakness, may be the determining factor in diphtheritic heart failure. In a few instances *acidosis* may play some part in producing some of the symptoms usually met with, notably the vomiting. It is difficult, however, to estimate the relative importance of the different factors noted above. We must imagine a seriously damaged muscle, often acting irregularly from impaired innervation, struggling with difficulties occasioned by a reduced venous supply to the auricles, a general vascular relaxation, and an actual reduction of the volume of blood.

Clinically, the failure of the circulation may occur early in the illness, probably within the first fortnight, or late. In the *early* cases the patient appears overwhelmed by toxæmia and the pulse becomes progressively worse. It is probable that some degree of palatal paralysis has been noted, and the urine is often loaded with albumin and much diminished in quantity. At first the heart sounds are regular and extra systoles uncommon. Later, reduplication of the second sound and gallop rhythm may be noted. Death may occasionally occur by sudden *syncope*, but more usually a warning is given by the onset of *vomiting*, which is

apt to persist till the end. Restlessness and *pain*, not always præcordial, but sometimes referred to the abdomen or some other situation, are often well marked for some hours before death, and the consciousness of the patient is usually acute. The end comes about twenty-four or forty-eight hours after the first vomit, and there may have been one or more attacks of syncope in the interval. Sudden death may occur in persons who have been allowed to exert themselves, even in the first week of illness, and some deaths on the table during tracheotomy or intubation are undoubtedly due to cardiac failure.

Even after the first fortnight is over, the patient is by no means free from risk, and unless all exertion is avoided, unpleasant accidents may happen. It must be admitted that *late* heart failure usually occurs in patients whose pulse has continued to cause anxiety, but it is extremely difficult to predict in which case out of many presenting similar symptoms an accident is likely to occur. While the collapse may be caused by some exertion, such as sitting up in bed, straining on a bed-pan, or even reaching to pick up something from a chair at the bedside, in some cases the first signs are noticed while the patient is asleep. A sudden change in the rate of the pulse, which may become accelerated or diminished in frequency, may be the first warning, or the patient may wake up and vomit. Thereafter syncope and pain are apt to follow as before, and when these three signs occur together there is practically no chance of recovery. The outlook is better if the collapse can be traced to a definite act of exertion.

Among other important signs of heart failure may be mentioned a gradual increase in the liver dulness, which may precede the attacks of vomiting or syncope

by some days. Once the failure has declared itself, the patient is very pale or livid, with cold extremities and imperceptible pulse.

It is difficult to say how late in the illness the heart is likely to fail. Patients who have shown no signs of paralysis are probably free from risk by the sixth week, provided the pulse is satisfactory. In severe cases, however, with generalized paralysis death may occur several weeks later from cardiac failure, and in all cases any violent exertion is to be deprecated for some time after an attack of diphtheria.

Post - Diphtheritic Paralysis. — This condition depends on degeneration of peripheral nerves, and except in very severe attacks is not usually observed in the first fortnight of the illness. Only some of the nerve fibres suffer, and the result is rather a paresis than a paralysis. While in carefully treated patients this sequel of diphtheria is only to be expected in moderate and severe cases, if the illness has been untreated it may follow a very mild attack. It is most common in patients who have suffered from nasopharyngeal lesions, and least frequently seen in purely laryngeal and tracheal cases. It may be expected to occur in about 10 or 11 per cent. of the individuals treated.

The muscle most commonly affected is that of the *soft palate*. In severe cases of the disease the paralysis may occur early, sometimes before the end of the first week, but the most common time for its appearance is from two to four weeks after the onset. Loss of function is evidenced firstly by the regurgitation of fluids through the nose during deglutition, and secondly by the distinctly nasal twang given to the voice. The latter may be best detected by asking the patient to repeat test sentences. Thus, for "Billy Button bought a buttered biscuit," the patient is likely to say, "Milly

Mutton mought a muttered miscuit," and he is also apt to change d's into n's. In well-marked cases the palatal reflex is abolished, and the soft palate hangs flaccid and immobile. Palatal paresis may only last a short time, sometimes indeed not more than ten days, but it is usually obvious for two or three weeks. Like all other forms of post-diphtheritic paralysis, even when persistent, it tends to ultimate recovery.

Paralysis of the *ciliary muscle* is also comparatively frequent, and the patient loses his power of accommodation, being unable to read or to pick up small objects. It is difficult to make certain of in children who have not learned to read. It may occur as early as the third week, and is occasionally met with as late as the seventh or eighth. It does not, on an average, tend to last for more than three weeks. Paralysis of the *ocular motor muscles*, especially of the external rectus, is fairly common, and is evidenced by some degree of strabismus. Perhaps the most frequent time for its appearance is the fourth week, and it seldom lasts long.

Paralysis of the *lower extremities* is also a common variety. It is as a rule not complete, and all that may be noticed is an ataxic gait and abolition of the knee-jerks. The plantar reflex is also abolished, and there is usually some degree of analgesia and paræsthesia of the legs. The muscles are soft and flabby, and sometimes wasted. This form of paresis is usually first recognized when the patient is allowed out of bed, say in the fifth week, and may persist for some weeks.

Paralysis of the *pharyngeal muscles* seldom occurs unless the attack has been very severe, and rarely appears before the fifth or sixth week of illness, sometimes being postponed until even later. The symptoms are a tendency to cough and splutter in attempting to take food, and difficulty in deglutition. The patient,

if not watched, may actually choke, or food particles getting into his lungs may set up an intractable pneumonia. A great source of discomfort is the inability to swallow the saliva which collects at the back of the throat and helps to excite the cough. In some cases the laryngeal muscles are probably also involved. Pharyngeal paralysis is one of the most dangerous sequelæ of diphtheria, but it is fortunately short-lived and is often recovered from within a fortnight. It is, however, occasionally associated with paralysis of the *respiratory muscles*, of which either the diaphragm or the intercostals may become affected, usually with fatal results.

Of the other muscles which may become involved, either separately or together with some already mentioned, are those of the neck and trunk, those of the upper extremity, the facial muscles, the levator palpebræ superioris, and the adductor and abductor muscles of the larynx. None of these are often affected, paralysis of the arm for instance being very rare. When three or four muscles are implicated together, the paralysis is spoken of as "generalized." Fortunately the usual tendency is for one form of paresis to be improving by the time a second appears. And in all cases, except when the pharynx or respiratory muscles are involved, the prospect of ultimate recovery is very good.

Complications.—It is unusual for complications of much importance to occur. We have seen that nephritis is very rare and that endocarditis is most unusual. Laryngeal cases, however, are not infrequently followed or accompanied by *broncho-pneumonia*, which, while doubtless in many instances due to septic micro-organisms, is sometimes the result of a true diphtheritic infection. The complication is often fatal, especially in cases which have been subjected to

tracheotomy. As in the case of other infectious diseases, *otitis media* occasionally occurs in convalescence, and cervical adenitis, sometimes resulting in suppuration, is not infrequently observed. Labial herpes is comparatively common in some outbreaks of diphtheria.

Relapse.—While slight patching of the throat sometimes recurs in the convalescence of diphtheria, a serious relapse is most unusual. If it occurs, it is probably some three to four weeks after the primary attack. Occasionally a patched throat is noticed together with symptoms pointing to serum sickness, and it is not necessary to suppose that all instances of sore throat with exudation occurring in convalescence are diphtheritic in origin. *Second attacks* are quite common, many persons suffering twice, or even more frequently, from diphtheria.

Diagnosis.—The necessity for the early administration of serum makes it imperative that a case of diphtheria should be diagnosed as soon as possible. It is not by any means advisable to wait for a bacteriological report unless the symptoms are very mild and the nature of the case extremely doubtful. Should the patient appear really ill, it is wise to give a moderate dose of antitoxin at once, rather than run the risk of giving a true diphtheritic infection too long a start.

Clinical Diagnosis.—The first important thing is to remember to examine the throat. Many cases of diphtheria are missed from want of this simple precaution. Children often do not complain of the throat at all and can swallow perfectly well, and it is wise to recollect that no ailing child has been properly examined if the throat has not been inspected. If any patching or exudation is visible, the question arises whether it is diphtheritic in character. The *age* of the patient is in this connection not without significance. Young children seldom suffer from follicular

or suppurative tonsillitis, and in a child of under seven years of age, if scarlet fever can be excluded, the presumption is that the patch on the throat is likely to be due to diphtheria. In infants the possibility of thrush must of course be considered, but this seldom causes much difficulty. The *situation* of the lesion is very important. Positions especially characteristic of diphtheria are the uvula, the soft palate, and the pillars of the fauces, all of which are more or less spared by other throat inflammations. Exudation on the uvula should always be treated as diphtheria until it is proved to be due to some other cause, Vincent's angina for example. If the exudation is limited to one tonsil, its unilateral situation should be regarded as suspicious of diphtheria, as the conditions simulating that disease are usually bilateral. Any speck on the fauces, however much unlike diphtheria, if associated with the slightest suggestion of croupiness or laryngitis, must be at once treated as such. As to the *appearances* presented by the exudation, we would expect the lesion to be continuous and not discretely spotted, although diphtheria occasionally starts in the tonsillar crypts and may present a follicular appearance for a few hours. While the disease cannot be excluded because the membrane is definitely white or yellow in colour, a pearly grey tint is highly suggestive. In diphtheria the surrounding mucous membranes are usually much less inflamed than in those conditions in which the exudation resembles it. While there is a margin of congestion round the edges of the membrane, the rest of the throat may be comparatively pale. Marked lesions with little general inflammation should always suggest diphtheria, it being thoroughly understood that much œdema and redness do not necessarily exclude its diagnosis. As regards the behaviour of the suspicious patch itself, if subjected to swabbing,

exudation which wipes off readily and without hæmorrhage is not likely to be diphtheritic, whereas a patch which is firmly adherent and if detached leaves a bleeding surface behind it is almost certainly so. The advantage of firm swabbing of the throat is that whatever is detached can be carefully examined and, if necessary, floated out in water, and its nature can thus be readily ascertained. Other points in favour of a diagnosis of diphtheria are absence of pain, pyrexia moderate in proportion to the lesions or non-existent, and the presence of albuminuria. The throat conditions usually mistaken for diphtheria are apt to be painful, are often accompanied by considerable fever, and are not likely to be associated with albuminuria unless the temperature is really high, say 103° or over. The occurrence of any variety of diphtheritic paralysis in convalescence after a suspected throat is, of course, final.

Differential Diagnosis.—Faucial diphtheria must be differentiated from *follicular tonsillitis*. In this condition, however, the "spotted" appearance of the tonsils and the absence of any continuous membrane should make the diagnosis clear. *Quinsy*, again, should not give much trouble, the asymmetrical swelling of the fauces and the protrusion downwards of the palate on the affected side showing the nature of the case. The quinsy patient, moreover, often has great difficulty in opening his mouth, a disability very seldom noticed in diphtheria. Nevertheless, the affected tonsil may be in some cases covered with a film of exuded pus which seen imperfectly through the narrow opening of the mouth looks very diphtheritic in character. It wipes off readily if swabbed. *Ulcerated throats*, the result of septic, syphilitic, or tubercular infection, can usually be distinguished, as ulceration and loss of tissue does not often occur in diphtheria. The difficulty, however, is to distinguish a shallow ulcer with a sloughy base

from actual membranous exudation. The patches of *thrush* are usually milk-white in colour, and the thin pellicle swabs off easily. Microscopic examination will reveal mycelia and spores.

The distinction of diphtheria from *scarlet fever* may be difficult if the patient is not seen until a time when it is possible that the rash of the latter disease may have disappeared. The patches on the throat in scarlet fever readily swab off, but in septic cases ulceration may be mistaken for membrane. The throat itself is usually much more uniformly congested than that of diphtheria, and the congestion of the soft palate is well marked. The condition of the tongue should also give valuable information, and in a doubtful case early desquamation should be looked for. In the septic cases of scarlet fever, most frequently mistaken for diphtheria, the temperature usually remains elevated at a period when in diphtheria it would be normal or subnormal. The face also remains flushed throughout, and does not assume the pallor which is well marked in most diphtheria patients a few days from the onset. Bacteriological assistance will often be required, and it must not be forgotten in this connection that the two diseases frequently coexist.

The condition known as *Vincent's angina* resembles diphtheria more closely than any other disease. It consists of an infective inflammation of the throat accompanied by the formation of a pseudo-membranous slough, which ultimately separates, leaving an ulcerated surface. It frequently is seen on the uvula and the margin of the soft palate; and in cases of supposed diphtheria in which bacteriological examination is negative, it is well to search for the spirilla and fusiform rods which are found associated in cases of Vincent's angina. It may be added that Vincent's organisms are often responsible for stomatitis and ulceration.

round the roots of the teeth, the condition described during the war as "trench mouth," and such ulceration, if present, gives a hint as to the real nature of the faucial lesions.

As regards conditions likely to be confused with the laryngeal form of diphtheria, if no faucial lesions are present to render the diagnosis easy, various forms of laryngitis, abscesses in the neighbourhood of the larynx, laryngismus stridulus, and acute œdema of the glottis must be remembered. A frequent mistake is to take the prodromal *laryngitis of measles*, which is not infrequently accompanied by considerable dyspnoea, for laryngeal diphtheria. If measles is epidemic, it is a grave error to notify a case with no faucial lesions as diphtheria unless the mucous membranes have first been carefully examined for Koplik's spots. Sneezing and lachrymation would also in such a case suggest measles. The laryngitis sometimes noticed in the catarrhal stage of whooping-cough is also occasionally a source of error. *Retropharyngeal abscess* may cause much laryngeal obstruction, and should be looked for if no other cause is obvious. The patient usually holds his head somewhat retracted, and the neck often presents more swelling than would be expected in a purely laryngeal case of diphtheria. In *laryngismus stridulus* the symptoms are a sudden spasm of apnoea followed as the cords relax by loud crowing gasps. The patient is often rickety, and is usually under two years of age. Convulsive movements and symptoms of tetany may accompany the paroxysm, and complete relief occurs in the intervals. Some patients suffering from severe broncho-pneumonia together with much cyanosis and dyspnoea are sent to hospital as diphtheria, particularly if they are at all hoarse. There may be some recession of the lower intercostal spaces which adds to the difficulty, but as a rule the physical signs are well

developed enough to clear up the diagnosis. Lastly, and especially if the symptoms of obstruction appear very suddenly, it may be worth while considering the possibility of a foreign body in the larynx.

Bacteriological Diagnosis.—A bacteriological examination should always be made, although in many cases it is unwise to wait for its result before giving serum. Useful information can often be obtained from the examination of a direct *smear preparation*. The film may be stained with Löffler's methylene-blue, which not only shows the general arrangement of the organisms but also brings out their segmented appearance. The presence of slender rods, characteristically grouped in masses or scattered through the field, and showing here and there V-shaped arrangements, is sufficient warrant for the injection of antitoxin. Cultures are made on Löffler's blood serum, and after about twelve hours' incubation at 37° C., small round whitish colonies are usually visible. For their examination the most useful stain is Neisser's acid methylene blue, picro erythrosin¹ being used as a counter-stain. Treated thus, the protoplasm of the bacilli is tinted a pale pink and the granules are almost black in colour. The film is stained first with the blue for from one to three seconds and washed lightly and rapidly, the counter-stain being used for the same time and then blotted or washed off. In cultures the characteristic feature of diphtheria organisms is the beading, especially at the extremities. The bacillus of Hofmann, often found in the throat, is shorter and shows even staining.

As to the *value of bacteriological examination*, it should be remembered first that bacilli in the throat do not necessarily mean that a patient is infected with

¹ Equal parts of a 1 per cent. aqueous solution of picric acid and of a 1 per cent. aqueous solution of erythrosin. Enough lithium carbonate to cover the bottom of the bottle is required to keep the mixture in solution.

diphtheria, and second that a negative examination means little or nothing unless cultures have been made on several occasions. If fairly definite lesions are present and the culture is positive, it may be assumed the condition is diphtheria; if lesions are wanting, a positive result simply means the patient is a "carrier." Before regarding an individual as free from germs, two or three consecutive negative cultures are necessary. It must be again repeated that if the clinical symptoms point to diphtheria, the results of cultures must not be waited for, and if negative must be disregarded.

Prognosis.—In spite of the wonderful results of serum treatment, diphtheria is still a dangerous disease, and the prognosis in patients who present definite membrane must always be guarded, particularly so if they have failed to receive antitoxin before the fourth day of illness. About 90 per cent. of patients may be confidently expected to recover, always provided that they have had serum treatment and that great care is exercised during their convalescence. As regards specific points, we are most influenced by the day on which serum is first given. The mortality of patients injected during the first three days of illness is very trifling, but it increases with each subsequent day which elapses before injection, and by the end of the first week may be 20 per cent. The situation of the lesions also affects prognosis. Nasopharyngeal cases have a very high death-rate, and are also particularly subject to paralytic sequelæ. Laryngeal cases have great risks to run during the time the obstruction is present. Thereafter, unless there are also severe faucial or nasal lesions, their outlook is good. In faucial cases, if the membrane is limited to the tonsils, the prognosis is considerably better than if the uvula or palate is involved. Hæmorrhagic cases cannot be expected to recover. The appearance

of the patient is often of assistance, as sometimes his waxy pallor suggests an amount of toxæmia which would not be expected from the extent of his lesions. Early albuminuria, drowsiness, much glandular enlargement, and a pulse which is either unduly fast or slow, are bad signs. A normal or low temperature must not be regarded as a favourable sign. If it falls much below the normal line the outlook is often serious. In laryngeal cases, however, with broncho-pneumonic complications a return of the temperature to normal may be welcomed. As regards age, as a broad rule, the younger the patient the more grave is the prognosis.

During convalescence sudden changes in the rate or character of the pulse should cause anxiety, and although vomiting in certain instances is merely due to some trivial stomach ailment, it should nevertheless always cause alarm, as, if not necessarily a sign of cardiac failure, it may, if prolonged or repeated, precipitate such a result. When failure occurs, it is wise to hold out no hopes of recovery. Paralysis, if it spares the respiratory muscles, may be expected to pass off sooner or later. The pharyngeal form, however, may be extremely dangerous owing to the risk of choking. Much as regards prognosis depends upon the management in convalescence. The less certainty we have that any given patient will be kept a sufficient time in the recumbent posture, or that care will be taken in dieting and nursing, the more guarded, even for the mildest cases, the prognosis must be.

Treatment.—The treatment of diphtheria is very simple. It consists in giving the patient an adequate amount of antitoxin, and in maintaining him in the recumbent position for about three weeks, or longer if the condition of the heart indicates it. We will first consider the general management and diet, and then describe the serum treatment.

Management and Diet.—From the moment diphtheria is diagnosed the patient must be kept flat and forbidden the slightest exertion. He is on no account to be allowed to sit up. One soft pillow is sufficient, as it is desirable to keep the head low. Active movements, such as reaching to the bedside table for toys or books, must be strictly forbidden. The bowels should be carefully regulated to avoid straining at stool. Reading should not be indulged in for a fortnight, even in mild adult cases. It is undoubtedly the case that undue exercise of any function is apt to encourage paresis, and this is especially true of accommodation and oculomotor paralysis. After a fortnight, when the lesions have been trifling, adults may be allowed to read for half an hour or so at stated times. Towards the end of the third week, provided the pulse is satisfactory, a second pillow may be allowed, and thereafter the patient may be gradually propped up, and perhaps be allowed out of bed by the end of the fourth week. In severe cases, however, or moderate cases followed by pulse irregularity, it is necessary to keep the patient absolutely recumbent for six or seven weeks.

The nurse should take pulse and temperature every four hours, and report at once any marked change in the pulse rate, any vomiting, any complaint of faintness or pain, or any paralytic symptom which comes under her notice.

The *diet* should at first be fluid and as liberal as possible. Milk, custard, strong beef tea, and so forth, should be given. When all fever has subsided, soft solids and in mild cases an ordinary diet may be allowed. It is unnecessary to modify the diet on account of albuminuria. The object should be to maintain the strength by suitable feeding. In cases of tracheotomy or intubation the nasal tube will be required, and it should also be used at once if there

is any suggestion of pharyngeal paralysis. Rectal feeding must be resorted to if there is persistent vomiting.

The diphtheria patient takes *stimulants* well and is usually the better for them. It is wise to give very small amounts of whisky at regular intervals as a routine, except in the mildest cases. If there is any tendency to vomiting, brandy is tolerated better, and champagne may be tried for cardiac sickness.

A very secondary part is played by *drugs* in the treatment of diphtheria. Strychnine given systematically is useful, but it cannot be said either to avert cardiac syncope or to be of any use when the latter has occurred. It probably, however, is of real value in the treatment of paralysis. Iron is to be recommended in some form or other during convalescence, and some preparation of the nature of Easton's or Fellowes' syrup may be used with advantage (see below, p. 264).

Serum Treatment.—To prepare an antitoxic serum it is first necessary to cultivate diphtheria bacilli upon a suitable fluid medium. During growth large quantities of toxin are given off into the fluid, and after about a fortnight the culture is passed through a porcelain filter which retains the bacilli, the filtrate being a strong solution of diphtheria toxin. This is standardized by the determination of its action upon small animals. The minimum lethal dose, or *toxic unit*, is that amount of toxin which will cause the death of a guinea-pig weighing 250 grammes in four days. One-tenth of a cubic centimetre of an averagely strong toxin should be sufficient for this purpose.

A small dose of this toxin is injected into a horse. A local reaction follows, and there is some fever and constitutional disturbance. When these subside, a second larger dose is given, and gradually increasing doses are injected at intervals until very large quantities

are tolerated. The antitoxic power of the blood continues to increase until, about six months after the first injection, it reaches its highest point. The horse can then be bled at suitable intervals, and the separated blood serum, with a small percentage of some suitable antiseptic added to it, becomes the antitoxin of commerce. It is hardly necessary to add that the greatest care is taken to see that the horses are free from disease and kept under hygienic conditions.

The *antitoxic unit* is the smallest amount of antitoxin which will neutralize one hundred times the minimum lethal dose given to a guinea-pig of appropriate weight. The dosage of serum is determined by the number of units employed. Some serums are much more potent than others, and as a result the actual amount of serum injected is no guide as to the number of units given. An average serum contains about 500 units per cubic centimetre, but much more potent preparations can be obtained at an increased cost.

The *value of serum treatment* is beyond dispute. While it is true that bacteriological diagnosis has caused the inclusion in our statistics of many mild cases which in other days would not have been regarded as diphtheria, the case death-rate of the disease has been reduced to a much greater extent than the addition of these cases would account for. Laryngeal diphtheria, a condition as easily recognized before bacteriology was in vogue as to-day, is much less fatal than in the days before serum was employed. And the reduction in the mortality of a still more fixed type of case, the laryngeal case severe enough to require tracheotomy, is even more remarkable. Another point of great importance in estimating the value of the treatment is the fact that mortality

increases with each day the first dose of antitoxin is delayed.

There are many excellent serums on the market, and as good results are as likely to be obtained with one as with another. In administering a dose it is well to have a clear conception of what we can expect it to effect. We may confidently hope that, if adequate, it will prevent any further extension of existing lesions, and that it will hasten the breaking up and separation of the membrane. We can also expect it to neutralize any free toxin which is circulating in the blood, and possibly also to detach any toxin which has only recently entered into loose combination with the tissues. But we cannot hope that it will have any effect on damage already done to the tissues, and this is the great reason for early employment of serum before such damage has been effected.

Although there is great difference of opinion as to *dosage*, we will not go far wrong if we regard 10,000 units as a maximum single dose, which will, of course, be reserved for serious cases and repeated if necessary. As a minimum therapeutic dose 1500 units may be quite useful if given to a mild case on the first or second day of illness. As an average dose, for patients with tonsillar lesions only, 3000 to 4000 units is to be recommended, and an extra 1000 units added for lesions in other situations such as the palate, uvula, larynx, or nose. Nasopharyngeal cases with much membrane and discharge will usually require from 8000 to 10,000 units, which often will have to be repeated.

Clinically it is found that for similar lesions a dose of say 3000 units given on the first day of illness will do much more than will double or treble that amount on the fourth or fifth.

In serious cases with extensive lesions and much toxæmia, it may be necessary to repeat 6000 or 8000 unit doses at intervals of eight, twelve, or twenty-four hours, until perhaps 36,000 or 40,000 units, or more, have been given. It is doubtful if much is to be gained by pushing the serum further, unless improvement after each dose is manifest.

It will be noticed that the character and extent of the lesions is used as a guide to dosage. As to age, it may be stated that children suffer most severely from diphtheria, and require, if anything, larger amounts of serum than adults. For infants of under a year 4000 units is sufficient as a single dose, but may be repeated if necessary. With this exception age need not influence the amount given.

It is right to add that in the opinion of some very reliable authorities serum should be given in a single dose, and if necessary in a large amount. The object being to obtain rapidly a high antitoxin content in the blood, this method has theoretically great advantages. It has been stated also that it is quite unnecessary to make the dose larger than from 20,000 to 30,000 units.

In the treatment of *relapses* it is well to withhold antitoxin unless the symptoms are very urgent and severe. The patient has been sensitized to serum and is liable to suffer unduly severely from serum sequelæ.

As regards the *administration of the serum*, it may be given either subcutaneously or directly into a muscle or vein. *Subcutaneous* injections require a greater length of time for complete absorption than do the others, and in very severe cases it is preferable to introduce the serum directly into a vein. This procedure, however, is seldom practicable in children with fat arms and collapsed veins, and is more suitable for older children and adults. The employment of the

intravenous injection is therefore limited, but it always has the advantage of immediately securing a high anti-toxin content in the blood. Probably *intramuscular* injections are the most generally useful. The serum may be introduced into the outer aspect of the thigh and is said to reach the blood stream far more rapidly than by the subcutaneous route. Whatever method is used, great care must be taken to secure asepsis, the needles being sterilized and the skin prepared with iodine. The puncture is sealed with a little cotton wool and collodion.

Serum Sickness.—Certain sequelæ are liable to follow serum injections, sometimes almost immediately, but usually in from seven to eleven days after the dose is given. In some instances the “serum phenomena” do not occur till the third or fourth week. There are three prominent symptoms of serum sickness. First and most commonly rash, second pyrexia, and third arthritis. These may occur separately or all together. Serum sickness is not due to the actual antitoxic substances, but merely to the foreign protein in the serum. It is believed that antibodies to this protein are produced in the blood and, after a varying interval, have developed or accumulated sufficiently to interact with any serum which may remain in the body cells. This interaction results in a substance capable of producing the phenomena described above which are regarded as anaphylactic in character. It has been suggested that the different proteins in the serum are responsible for the different types of rashes liable to occur, and that each particular type of rash has a fairly constant incubation period.

Antitoxin *rashes* are very common, occurring in from 10 to over 60 per cent. of the patients treated. For the most part they are unaccompanied by fever or constitutional symptoms. They often

assume the type of a *multiform erythema*, an irregularly blotched rash of a bluish pink colour, in places almost morbilliform, in others erythematous, and elsewhere presenting large urticarial-looking plaques without the characteristic wheals. Here and there circinate patches may be observed. There is often puffiness of the face, and sometimes slight œdema of the extremities. The most common type of rash is the *urticarial*, usually occurring about the ninth day after injection and characterized by the formation of wheals and by intense irritation. Other rashes are purely *morbilliform*, and, except for the complete absence of coryza and constitutional symptoms, might well be taken for measles itself. Others, again, are *scarlatiniform*, and it is these which give the greatest trouble in diagnosis, as the resemblance to scarlet fever is often very striking. They often, however, present no constitutional symptoms, they tend to be irritable, and the tongue and throat are not characteristic. They are apt to appear soon, two or three days, after the dose is administered, and the punctate erythema is sometimes observed first in the neighbourhood of the site of injection. It is not unusual for two rashes of different types to succeed each other in the same patient.

The *arthritis* sometimes occurs alone, but is usually seen in connection with a rash. There is not much swelling of the joint, but considerable tenderness and much pain on movement may be present. The condition is not very common, and is not likely to be met with in more than 5 per cent. of all cases. On the other hand, *pyrexia* is relatively frequent, usually accompanying joint pains, and sometimes occurring with the rash.

Abscesses forming at the site of injection must be regarded as due to sepsis.

PLATE VI.



A SERUM RASH, SOMEWHAT IRREGULARLY DISTRIBUTED ON THE
LOWER EXTREMITIES.

To face page 262.

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Risks of Anaphylaxis.—Although ordinary serum sickness need cause no anxiety, it must be remembered that occasionally the injection of even a small quantity of serum has caused serious, or actually fatal, shock. Such accidents are fortunately extremely rare. Several of the fatal cases reported have occurred in persons who had never had a previous dose of serum, but alarming sequelæ are more to be expected in patients who have at some earlier date been sensitized to horse-serum by a therapeutic or prophylactic injection. In this latter class we must include all men who were wounded in the war, as the prophylactic use of anti-tetanic serum was almost universal. It has also been observed that asthmatics are peculiarly liable to suffer from shock and immediate serum reactions.

It is safe to repeat doses of serum at any time within ten days of the last injection, but thereafter the patient must be regarded as sensitized. It is uncertain how long the dangerous period lasts, but apparently it may continue for three years or longer. While it is true that man is much less susceptible to anaphylaxis than are laboratory animals, and that its risks have been much exaggerated, it is none the less wise to de-sensitize any patient who has previously received serum within the limits named or who is an asthmatic. *De-sensitization* may be effected by the subcutaneous injection of a few drops of serum, and the therapeutic dose may be given into the muscles about four hours later. The injection of atropine, gr. $\frac{1}{150}$, is also said to prevent shock. Should the latter occur it should be treated with stimulants, hot bottles, hot fomentations over the heart, and the intravenous injection of atropine or adrenalin.

Local Treatment.—This takes a very secondary position when compared with the serum treatment and general management of a case. It is nevertheless well

to keep the mouth and throat as clean as possible by frequent swabbing with non-irritating antiseptics. No forcible attempts to detach membrane should be made, but loose fragments may be removed. Should there be much hæmorrhage, the fauces may be occasionally swabbed with adrenalin. Suitable preparations to keep the throat and nose clean are boroglyceride, Löffler's solution of toluol, and sprays of either 1-4000 corrosive sublimate or peroxide of hydrogen. Gargles of listerine, or some similar antiseptic, in hot water are also useful, and for adults with much faucial œdema steam inhalations are very comforting. It may be noted that some good authorities have entirely dispensed with local treatment of any kind, and in very severe cases the exertion, which it entails, more than neutralizes its value.

Treatment of Circulatory Failure and Paralysis.

—It is to be regretted that the scientific work on *circulatory failure* has so far given us little or no assistance as regards treatment. The most important preventive measure is undoubtedly to secure complete rest and to keep the head low. Such a simple precaution as raising the foot of the bed of a patient whose pulse shows signs of failing probably assists in maintaining a circulatory equilibrium which might otherwise break down. Such drugs as strophanthus and digitalis are always useless and quite probably dangerous. Adrenalin given intra-muscularly from the first is possibly of value, if the heart sounds are fairly regular and distinct, and should theoretically be useful if adrenal insufficiency plays any part in the causation of failure. Should there be any reason at any time in the course of the case to suspect acidosis, it appears reasonable to give bicarbonate of soda freely and preferably per rectum. When the breakdown has occurred, any tendency to syncope should be treated by hot

fomentations over the heart and by injections of ether, strychnine, or camphor in oil. Saline injections should be given by the rectum. Pain and restlessness justify the very cautious administration of morphia combined with atropine, and the complete rest which is sometimes secured certainly prolongs life and occasionally appears to preserve it. The feeding should be entirely rectal, but iced brandy, or champagne, is sometimes well tolerated by the stomach.

Paralysis is best treated by complete rest of function and the internal administration of strychnine. Electrical treatment is of no use. Should pharyngeal paralysis occur, it often helps the patient if the foot of the bed is raised, as saliva tends to flow out of the mouth rather than to collect over the glottis. The nasal tube should be always employed for feeding purposes. Antitoxin should not be given, firstly because it does no good, secondly because, the patient having been sensitized to it, a second dose after a long interval may cause unduly severe serum sequelæ.

Treatment of Laryngeal Diphtheria.—The great object at first will be to avoid operation if possible. Everything should be done to palliate the condition and to give time for the serum, which should be given immediately, to exercise its action. The breathing is usually much relieved by the steam kettle, and the application of hot fomentations to the throat is often useful. In sthenic cases on the first day of illness the old plan of freely administering ipecacuanha wine has its advantages, but as the disease progresses the condition of the heart is not likely to encourage an emetic treatment. Belladonna pushed freely is of considerable value in relaxing spasm. The patient nearly always requires alcoholic stimulation.

Indications for Operative Interference.—In private practice, where the medical man cannot be in constant

attendance, it is obviously wise to operate early. Should dyspnœa be present with definite recession of the soft parts of the chest, it is difficult to see how the patient can be safely left unless tracheotomy is performed. If the child cannot be sent to hospital, the best course is to operate at once.

In *hospital practice*, on the other hand, it is well to wait as long as possible, and the condition of the pulse is in the long-run the safest guide. Provided a medical man is always within reach, the patient may be allowed to enter the third stage of croup. It is also advisable to consider the time the patient has been ill. If there is reason to believe that the toxins have had time to affect the cardiac muscle, we would naturally not postpone operation too long for fear of death from shock on the table.

Tracheotomy and Intubation.—In this country intubation is not regarded as a suitable operation to employ in private practice, although in some hospitals, including the Edinburgh City Hospital, it is practised as the operation of election. It is therefore sufficient to say that it consists of the introduction, by means of a special instrument, of a vulcanite tube into the larynx. The tube is retained in position by its own weight, by its shape which expands below the constriction which lies in the glottis, and by its rounded head which is supported by the aryteno-epiglottic folds of mucous membrane. It may be worn for as long as three or four weeks without injury to the larynx, but in most cases can be removed safely within three days. From its liability to be coughed out, and from the fact that a nurse cannot be expected to be able to replace it, its use is contraindicated, unless a doctor is always ready to reintubate if required.

Tracheotomy, then, will be the operation selected by the general practitioner. If the symptoms are not too

urgent, the skin of the throat and upper part of the chest should be carefully cleansed and prepared. Unless the patient is moribund, an anæsthetic is advisable, and if the patient has not been ill for more than three or four days he will probably stand chloroform well. Should, however, the illness have lasted longer, eucaine may be used with advantage as a local anæsthetic. The child should be immobilized by a blanket wound round the limbs and trunk up to the level of the nipple. The head should be held firmly by an assistant, the back of the neck resting on a rolled sheet or sand-bag of about 6 inches in diameter. The operator standing on the right of the patient satisfies himself as to the position of the cricoid cartilage, and, having discovered this anatomical point, is careful not to lose it. Steadying the larynx between the thumb and middle finger of the left hand, with the forefinger resting on the lower margin of the cricoid, he then makes his skin incision downwards from the tip of the finger, being careful to keep the middle line. About an inch and a half is the usual length of incision required. Once the skin is divided, if the patient appears *in extremis*, a bold plunge into the trachea is quite justifiable, the left forefinger being shifted into the wound and still marking the lower margin of the cricoid. When time is no particular object it is well to dissect more slowly down to the trachea, not paying too much attention to hæmorrhage, which can be trusted to stop when the dyspnœa is relieved. The covering aponeurosis of the trachea must be thoroughly divided and the trachea itself opened by an incision through the first two or three rings. The wound is then held open by dilators or by the handle of the knife held crosswise. No attempt should be made to insert the tube until the breathing is easy. Should any loose membrane be visible, an attempt may be made to remove it with laryngeal

forceps. A little manipulation is sometimes required to introduce the tube, but its lower end once in the opening it is easily manœuvred into position and tied by tapes passed through the openings in the shield and round the neck. A light gauze dressing covered with gutta-percha tissue is arranged round the shield.

A steam tent is not desirable in the after treatment of a case, but the air may with advantage be kept warm and moist by a croup kettle near the bed. The inner tube must be removed and cleaned occasionally. The wound may be dressed and the gauze changed twice a day. The feeding should be carried out entirely by the nasal tube. An attempt should be made, if the circumstances are favourable, to remove the tube in three days from the operation. The breathing can be tested by the removal of the inner tube and the plugging of the orifice, and if satisfactory the tube can be dispensed with. Some patients, however, wear a tracheotomy tube for weeks, the breathing being obstructed by granulations above or below the wound. Nervousness also is apt to hinder the removal.

Treatment of Carriers.—It is very difficult to find any satisfactory method of dealing with persistent carriers, whether "healthy" or "convalescent." Local antiseptic applications are of little use as the bacilli lie in the tonsillar crypts and are out of reach. Treatment with vaccines, detoxicated or otherwise, or with the endotoxin recommended by Hewlett, is very uncertain, although the latter sometimes appears to be really effective. Attempts to get rid of the bacilli by the use of sprays of living cultures of other micro-organisms, such as the lactic acid bacillus and the staphylococcus aureus, are only occasionally successful. In prolonged cases tonsillectomy and the removal of adenoids is well worth a trial, the latter procedure being especially helpful to nasal carriers. Nevertheless

time, rather than treatment, appears in many instances the only effectual agent. Patients whose bacilli are proved not to be virulent to laboratory animals may be released with reasonable safety, but should not be allowed to work in dairies or among young children.

Isolation and Quarantine.—It is customary to maintain isolation until at least two negative cultures have been obtained from the throat. This may in certain circumstances imply a long detention in hospital, as the bacilli are occasionally very persistent. It would be reasonable not to allow exposed children to return to school until a week has elapsed from the isolation of the last case, unless swabs taken from their throats give two consecutive negative cultures, in which case their return might be permitted earlier.

Prophylaxis.—An outbreak can be best dealt with by the notification and isolation of the actual cases, the disinfection of their rooms, and by special supervision of the schools. As regards the latter, it should be remembered that the common use of pencils, pen-holders, and towels may readily become a source of danger if one or two active carriers are among the pupils. Carriers, whether in the home or the school, should be looked for and isolated. It is well to make certain that the milk supply is above suspicion.

It may be necessary, if cases occur in rapid succession in an institution or large family, to arrange for the *immunization* of contacts. A *passive immunity*, which becomes effective after about twenty-four hours and can be depended on for three weeks, can be secured by the injection of a small dose, 500 to 1000 units, of serum. It has been objected that persons so treated are left sensitized, but the advantages of the method far outweigh the very remote risks of dangerous anaphylaxis should they require serum treatment of any kind at a subsequent date.

By injecting what are known as toxin-antitoxin mixtures an *active immunity* of quite possibly permanent duration can be produced. This method, introduced by von Behring, requires time (several months), and is therefore quite unsuited for immunization in an emergency. The toxin is almost neutralized by the antitoxin, and a sufficient quantity becomes dissociated on injection to stimulate the production of antitoxin by the body cells. Three injections of one cubic centimetre are given at intervals of seven days, and appear to cause little disturbance.

To test *susceptibility* to diphtheria the *Schick Reaction* is of great value. A small quantity, one-fiftieth of the minimum lethal dose for the guinea-pig, is injected intradermally, usually into the skin of the forearm. Care must be taken to see that the dose, which is contained in 0.2 c.c. of normal saline, gets actually into, and not under, the skin and produces a raised white wheal. If the blood of the individual tested contains sufficient natural antitoxin to protect him no reaction follows. If, on the other hand, he is susceptible, a circumscribed area of redness and slight infiltration, measuring from 1.0 to 2.5 cm. will appear in from twenty-four to forty-eight hours. This redness may persist for about a week, and on fading leaves a brownish pigmentation and superficial scaling.

The Public Health Department in New York is encouraging the population to secure immunity to diphtheria for their children by means of toxin-antitoxin mixtures. The injections are only required by those who show a positive Schick reaction, and this reaction is usually found to become negative in three months. Very little has been attempted in Great Britain, and there is some difficulty in obtaining either a suitable toxin for the Schick test or reliable toxin-antitoxin mixtures.

CHAPTER XII.

ERYSIPELAS.

Etiology.	Relapses and Second Attacks.
Period of Incubation.	Diagnosis.
Stage of Invasion.	Prognosis.
Facial Erysipelas.	Treatment.
Wandering Erysipelas.	Local Treatment.
Special Situations.	Isolation.
Phlegmonous Erysipelas.	Prophylaxis.
Complications.	

Synonyms—Rose; St. Anthony's Fire.

Etiology.—Fehleisen was the first to demonstrate that erysipelas was due to streptococcal infection, but his contention that the streptococcus concerned was a distinct organism from the *streptococcus pyogenes* has not been confirmed, and it may be assumed that the latter organism is usually responsible for the disease and that the differences noted clinically in the action of the germs can be explained by variation in the virulence of the infection, in the site of the inoculation, and in the resistance of the infected subject. Thus micro-organisms which are capable of causing puerperal fever in one person may cause erysipelas in another, and *vice versa*. It may be noted that other varieties of streptococci, notably the *streptococcus faecalis*, are capable of producing erysipelas. The streptococcus is found in the lymphatic vessels and spaces of the corium, and is most abundant in the area just beyond the spreading edge of the dermatitis. In the parts over which the inflammation is passing it is more difficult to find, the spaces being filled with large numbers of leucocytes,

It is reasonable to assume that a breach in the cuticle must exist before the streptococcus can obtain a nidus. This need be only a microscopic abrasion, and such cases, in which no wound is visible, used to be classed as "idiopathic" as contrasted with "traumatic," a distinction which to-day appears purely artificial.

As regards *predisposing causes*, climate appears to have but little influence, the disease occurring in all parts of the world. While cases occur in this country at all times of the year, the period from October to January furnishes the greatest number of patients. Cold winds and damp cold weather appear to predispose to the disease, possibly by chilling the skin of the face and limiting the protective blood supply. As to sex, erysipelas is more common in females than in males, although it is much more fatal in the latter. It is, if we except the newly-born, rare in persons of under fifteen years of age, but becomes comparatively common after the age of twenty is passed. After fifty years it is less frequently seen, but it may occur in persons of eighty and over. It seems to be unduly frequent in alcoholics, which is possibly accounted for by the increased chances of injury and exposure to which this class of individuals is liable.

Dissemination and Infection.—The disease used to occur in outbreaks in surgical wards, but the possibility of this has been now prevented both by modern sanitation and antisepsis. Clean operation wounds seem more vulnerable than those in which septic infection is already present. The infection is liable to be carried on the hands or instruments of a surgeon or dresser. Fomites may retain infection for some time, and an outbreak among surgical patients has been traced to the pillows of an operating table.

Incubation.—From about three to eight days is a

probable period. In the cases experimentally inoculated by Fehleisen the latent stage varied from fifteen to sixty-one hours.

Invasion.—The onset of erysipelas is sudden. Shivering is the most constant symptom, and actual rigors often occur. The temperature runs up to high levels at once. Headache is common, and many patients vomit. Sore throat is occasionally complained of. These symptoms may appear synchronously with the first signs of the erysipelatous flush, or may precede it by a few hours.

Facial Erysipelas.—In the great majority of cases erysipelas takes its origin in an abrasion on the face, and it is convenient to describe the disease as met with in this situation. The starting-point is often the inner canthus of the eyelids or the neighbourhood of the nostril. A patch of redness appears and rapidly spreads over the face. The skin becomes deep red in colour, swollen, and sometimes shiny. It is tense to the touch and feels hot. The inflamed area is raised above the normal skin, and its margin is felt as a raised ledge, the *spreading edge* of erysipelas. There is much local discomfort, a burning sensation and stiffness of the skin being usually complained of.

The advance of the dermatitis varies in rapidity, and to some extent is influenced by the character of the tissues over which it passes, the spread being most rapid where the skin is lax, as for instance in the neighbourhood of the eyelids. The inflamed area may assume butterfly or spectacle patterns as it spreads across the nose. The eyes are nearly always completely closed by the œdema. The dermatitis spreads much like water on blotting-paper, often throwing out small tongue-like projections. The advance is often checked in places where the skin is tense, as at the edge of the scalp or the line of the lower jaw. Should

it pass these points, the erysipelatous inflammation will usually involve the whole scalp, or pass some way down the neck and perhaps spread over the whole body.

In sharp cases it is usual to see *blebs* or blisters of varying size form on the inflamed skin, and occasionally superficial necrosis takes place in small areas. *Desquamation*, often very profuse, almost invariably follows. While the disease is at its height the patient presents a very characteristic appearance. The whole face is enormously swollen and of a deep red colour, and the eyes are closed. The ears are often swollen and blistered. The patient suffers much if the scalp is invaded, as its tenderness makes it impossible for him to lay his head on the pillow without pain.

In the majority of patients the temperature remains at high levels throughout the attack. Mild cases may suffer little from fever or may present good morning remissions, but as a rule the pyrexia is sustained, and this is particularly the case if the scalp is involved. With the cessation of the acute process the temperature tends to fall abruptly, a *crisis* being noted in a high percentage of cases. It is impossible, however, to say when this amelioration is likely to occur, as the duration of the disease varies very considerably. Still, in most instances, if the disease is limited to the face, the crisis will appear some time between the fifth and tenth days.

Constitutional symptoms are usually severe. The pulse is accelerated in proportion to the elevation of the temperature. Head symptoms are common, especially if the scalp is affected. Headache is severe from the first, and insomnia is often persistent and intractable. Delirium is also common, and may assume an excited type in persons who are alcoholic. Meningitis is rare, but it may be simulated by symptoms depending on

toxæmia. Albuminuria is frequently observed. As in other fevers, congestion of the lungs and hypostatic pneumonia may supervene in very prostrate patients. Death may result either from this cause or heart failure.

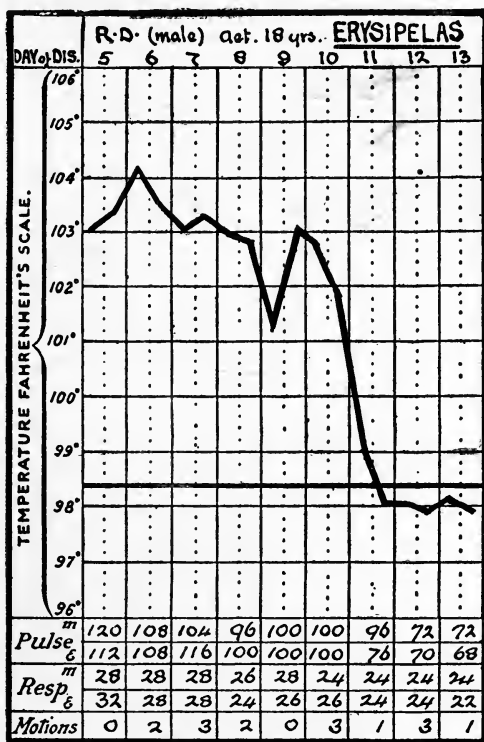


FIG. 13.—Facial Erysipelas. Showing crisis.

Wandering Erysipelas.—The dermatitis may wander from the head and advance over the trunk and limbs. In such a case its usual course is from the scalp and by the back of the neck. It may stop at any point, but common situations for its cessation or retardation

are the costal margin, the crest of the ilium, and the upper part of the thigh below the buttocks. In this wandering type of the disease the temperature is apt to assume an intermittent character, showing great variation between the morning and evening levels. It may be many weeks before the advance stops, and sometimes the dermatitis, after having passed once over the body, returns again, invading the same situations as before. This type of the illness is extremely exhausting, and death sometimes occurs before the process shows any sign of ceasing.

Special Situations.—While facial erysipelas is the most common variety, the disease frequently starts from a wound or abrasion on one of the *extremities* or on the trunk. The *genital organs* both in the male and female are sometimes first attacked. While in most instances the spread is limited, in some the dermatitis wanders over the body, as described above.

The *fauces* are sometimes the site of the primary lesion, spread occurring to the face by way of the mouth or nose, or again the inflammatory process originating on the face may attack the mucous membranes of the mouth and fauces. There is much œdema in these cases, and the fauces become dark red in colour. The *larynx* is occasionally but rarely implicated, and some otherwise unexplained cases of acute œdema glottidis have been attributed to primary erysipelas in this situation. The lungs are in some cases the site of secondary pneumonia, which may be streptococcal in nature.

Erysipelas neonatorum is the result of infection at the navel shortly after birth. The symptoms are similar to those of erysipelas in other situations, but the margin is seldom very definitely raised. The dermatitis is apt to spread considerably, and the buttocks and genital organs are frequently involved.

There may be much superficial necrosis of the skin, and the condition is a very dangerous one.

Erysipelas occasionally follows *vaccination*, and is usually due to the late infection of a neglected sore.

Phlegmonous Erysipelas.—When the deeper structures are involved erysipelas is said to be phlegmonous, and it has been suggested that the condition is due to a mixed infection. Accompanying the ordinary and superficial skin inflammation is a subjacent cellulitis which may keep pace with its spread or be merely located near the original site of infection. Suppuration often occurs, although in many cases no pus is found on incision, and there is much sloughing of the cellular tissue. In very severe cases gangrene may ensue, and the condition is always dangerous, some patients succumbing to prolonged suppuration.

Complications.—The most important is bronchopneumonia, which is apt to occur in prolonged cases. Meningitis is rare. Nephritis is sometimes but not often observed. Abscesses are common, and are often seen in the lower eyelids. Diarrhoea is sometimes serious enough to become a dangerous complication in cases of the “wandering” variety of the disease.

Relapses and Second Attacks.—*Relapses* are very common, occurring at any time from within a few days of the primary attack. All the symptoms of the original fever are reproduced, and the inflammation usually starts from the primary site of infection. Several relapses are sometimes observed in one patient. *Second attacks* are also frequent, indeed about 17 per cent. of hospital patients have a history of having had erysipelas previously. The recurrent attack usually originates in the same situation as the first one, and the disease is especially liable to recur in persons who have a habit of picking the nose or scratching the eyelids. In certain patients relapses or second attacks

follow each other so continuously that the disease may be described as *chronic*.

Diagnosis.—The great feature by which an ordinary attack can be distinguished from other skin conditions is the definitely raised margin. In erysipelas, again, the intensity of the inflammation, the brightest colour, the greatest tenderness, and so forth, is better marked at the periphery than at the centre, whereas at the point of infection the inflammation may already be subsiding, and perhaps desquamation may be commencing. The presence of bullæ or vesicles is a strong argument in favour of a positive diagnosis. Should the swelling of the face extend to the neighbourhood of the ear the auricle is almost invariably implicated and becomes œdematous. In the swelling from a parotitis or an alveolar abscess the ear is unaffected. Lastly, constitutional symptoms are usually well marked in erysipelas, and distinguish it from most of the local conditions with which it may be confused. Of these we may mention the different forms of erythema, in which, however, the blush is not so uniform and is apt to be more blotched. Erythema nodosum shows a tender and raised area, but it is seldom that this is single, several being usually present. Cellulitis does not show so defined a margin, and is much more resistant and brawny when palpated. The tenderness, moreover, is best marked in the situation first attacked, and is but slight at the periphery. Occasionally, however, it is associated with real erysipelas.

Prognosis.—The case mortality from erysipelas is about 5 per cent. The disease is very fatal in the newly born, but the outlook in older children and young adults is very favourable. After the age of thirty years the mortality tends to increase, and after fifty years the condition should be regarded as a somewhat serious one, becoming extremely dangerous in

persons of over seventy years. Females above forty years of age seem to have a much better chance of recovery than males. The disease is apt to run a severe course in alcoholic subjects, and such a condition as chronic renal disease prejudices the chances of recovery. Erysipelas following a surgical operation or complicating another infectious illness, such as smallpox, is more likely to be serious. Severe head symptoms and much delirium must be regarded as bad signs.

It is impossible to predict how long any given case will last. A crisis with cessation of spread may occur as early as the third day or be postponed almost indefinitely. Even when spread has ceased for two days, there is no absolute certainty that the dermatitis will not resume its advance.

Treatment.—The uncertainty of the duration of the disease makes it extremely difficult to estimate the value of any treatment, as the vast majority of patients will make a rapid recovery whether treated or not, and the improvement is apt to be so sudden that it is only too often attributed to the last drug employed. It is, indeed, very doubtful if any mode of treatment exercises any real influence on the condition. It must be admitted, on the other hand, that much may be done for the comfort of the patient.

During the febrile stage the *diet* should be fluid unless the disease seems likely to be prolonged, in which case it is well to add soft solids, or even, if the digestion is good, such light solid foods as fish or chicken. In the wandering type of the illness a liberal diet is very necessary, and elderly persons and alcoholics will require stimulants. The patient should be kept in bed until the temperature has been completely normal for at least three days. There is no necessity to interfere with the course of the temperature, but if there is much headache the ice cap can be employed with

advantage. It is advisable to treat insomnia actively from the first, particularly in an alcoholic patient. One night's good sleep often prevents any further trouble. Sulphonal in a dose of 25 grains may be given early in the evening, and if the patient is not sleeping four hours afterwards, two drachms of paraldehyde will often effect the desired result. But, once started, hypnotics must be pushed till sleep is obtained. For the general weakness shown in prolonged cases strychnine is often very useful, and if the condition of the heart is unsatisfactory strophanthus or digitalis may be employed, although it is well not to expect too much from their use.

At one time iron had the reputation of being almost a specific for erysipelas, but its value has been much overrated. It certainly does not shorten the illness, and it has a tendency to upset the stomach. The tincture of the perchloride is the usual preparation employed, and doubtless has some tonic effect.

Serum and Vaccine Treatment.—Anti-streptococcic serum has been much used. It is, however, very disappointing. The dermatitis often continues to spread after repeated large doses. If given, it should be administered freely in injections of 50 c.c. at least repeated twice daily.

Vaccines have also been employed extensively, but their efficacy is not admitted by all who have used them although some reports are very favourable. It is at least certain that they often fail to check the advancing inflammation. Very varying doses are recommended, but it would seem reasonable to start with from 20 to 25 million streptococci and increase the dose gradually to 100 million, making the interval about three or four days. In very severe cases smaller amounts, 2 to 10 million, are advisable for the first inoculation, and the interval can be made shorter. Curiously enough better results are sometimes obtained

if a mixed vaccine is employed, and the addition of staphylococci, perhaps 500 million, may prove effective, possibly by increasing the general resistance.

Local Treatment.—The object of local treatment is twofold. In the first place, it is necessary to allay the pain and discomfort suffered by the patient. Secondly, it is often prescribed in the hope of limiting the spread of the dermatitis. It is well not to expect too much in this latter connection, as it may be confidently asserted that there is no method which can be depended upon to check the advance of the inflammation.

The local applications which have been suggested are very numerous, and are either *lotions*, unguents, or dusting powders. Thus lead lotion sprinkled on lint applied as a mask to the face gives considerable relief, or ichthyol in aqueous solution, of the strength of 1 in 10, is in most cases successful in allaying the burning sensation. A saturated solution of magnesium sulphate applied on lint and covered with oiled silk gives more comfort than anything else if it is kept thoroughly moist. It tends to reduce the inflammation and has the advantage of being a clean preparation. It is very effective if cellulitis is also present.

The use of *ointments* has the advantage of not requiring so frequent renewals of the application, and may be preferred. Simple vaseline or boric ointment may be found useful, but ichthyol, one part in ten of vaseline, is probably the most satisfactory ointment to use.

Dusting powders also give undoubted relief. Sub-nitrate of bismuth, boracic acid, and simple starch powder may be combined for this purpose in varying proportions. If nothing else is available, flour dredged freely over the part gives some comfort to the patient.

Of the various preparations which, it has been claimed, limit the advance, iodine has the best reputa-

tion, and should be applied in a broad band just free of the spreading edge. But even the liniment often fails to check the dermatitis, which passes rapidly over the painted area. Iodine can also be painted over the inflamed area, and as a palliative is perhaps as effective as some of the remedies already mentioned. Nitrate of silver and many other drugs have been painted on with the same object, but all fail in a certain proportion of cases. They are, like the iodine, supposed to check the advance by increasing leucocytosis in front of the spreading edge. Recently a 5 per cent. solution of methylene blue has been recommended, as has also a 5 per cent. aqueous solution of brilliant green.

When the tension of the skin is extreme, if hot fomentations, which may be sprinkled with laudanum, fail to improve the condition, free incisions must be made. Abscesses in the eyelid or elsewhere must be opened at once. If the throat is affected, the sucking of ice sometimes eases the pain, or inhalations of steam may be prescribed with advantage. The continuous warm bath has been recommended for children with erysipelas of the genital organs and surrounding parts.

Isolation.—The patient should be detained for a week after all acute symptoms have subsided.

Prophylaxis.—In surgical wards the spread of infection can be limited by scrupulous attention to asepsis and antisepsis. Doctors and nurses who have to deal with any type of erysipelas should be careful to disinfect their hands and to cover up any abrasions which may exist on them. No one in attendance on a case should also attend a confinement. As regards the prevention of the disease in persons who have already suffered from two or more attacks, the avoiding of picking the nose or scratching the eye or ear or whatever part is usually first attacked, is the point of chief

importance. Patients who suffer from irritation and cracking about the nostrils will often get good results by attention to the skin of the part, for instance by inserting a small piece of cold cream in each nostril at night. Prolonged exposure to cold winds should be avoided. A course of vaccines is always worth trying.

CHAPTER XIII.

WHOOPING-COUGH.

Etiology.	The Blood in Whooping-Cough.
Infection and Dissemination.	Second Attacks.
Pathology.	Diagnosis.
Period of Incubation.	Prognosis.
The Invasion or Catarrhal Stage.	Treatment.
The Paroxysmal Stage.	Specific Treatment.
Convalescence.	Isolation.
Complications and Sequelæ.	

Synonyms—Pertussis ; Chincough.

Etiology.—Whooping-cough is usually endemic in large cities, and is apt to occur in widespread epidemics at short intervals. It appears to be more common in northern climates, but has been carried all over the world. Its most usual season is from January to April. Of all the infectious diseases it is the most liable to attack very young children, being frequently seen in infants of under six months. The largest number of patients are in their fourth year, and after that is passed the number decreases with each year as age advances. No period of life, however, is exempt, and the disease has been met with in the aged. The relative immunity of adults appears to depend, as is the case with measles, upon the protection conferred by an attack in early life. Females at all ages are somewhat more frequently attacked than males.

Bacteriology.—The most probable organism is a short bacillus, described by Bordet and Gengou. It shows definite polar staining with a 5 per cent. solution

of phenol toluidin blue which colours it lilac, any other organisms present being coloured blue. It is most likely to be found in the catarrhal stage of the illness, and has been agglutinated by the blood of immune animals.

Infection and Dissemination.—Whooping-cough is usually transmitted by direct contact from person to person. The virus is contained in the expectoration, and is probably communicated by “droplet” infection. The infectivity of the disease is extremely high, but the bacillus seems short-lived outside the human body. It can, nevertheless, be carried on the clothes of a third person and thus communicate infection by indirect contact. Whooping-cough is most infectious in the catarrhal stage. There is, in fact, reason to believe that when the paroxysms are fully developed the patient is either no longer infectious or at least seldom causes infection. Careful disposal and disinfection of the sputum will in any case lessen the chances of the disease being communicated.

Pathology.—The bacillus probably first obtains a nidus in the respiratory tract, and causes there a local hyperæmia to which the catarrhal symptoms of the invasion period are due. The cilia of the trachea are said to be clogged by masses of bacilli and the mucus, instead of moving upwards, collects until it has to be expelled by a paroxysm of coughing. The toxins ultimately affect the nervous system, and perhaps the vagus nerve especially, and some regard the paroxysm as due to their action. The whole nervous system undoubtedly suffers in this disease, as is evidenced by the liability to convulsions and the general nervous irritability. Nothing is likely to be found at an autopsy unless complications have supervened.

Incubation Period.—This seems to be very variable, and is difficult to estimate, owing to the extremely insidious onset of the early catarrhal symptoms. It may, however, be calculated as varying from a few days

to a fortnight, and a person who shows no suggestion of catarrh fifteen days after exposure may be regarded as free from the risk of developing the disease.

The Invasion or Catarrhal Stage.—The first symptom is usually cough, and a few patients may suffer from coryza. There is sometimes, but not invariably, slight fever remittent in character with evening rises. Many children are dull and lose interest in their toys, and some have loss of appetite and general malaise. The sleep is apt to be restless and disturbed. Laryngitis may occur at this early stage, and some patients may even suffer from slight dyspnoea. The most obvious symptom of the prodromal period is, however, the cough, which is short and dry in character, and which at first does not occur in paroxysms. Towards the end of this stage, which may last from a few days to a fortnight in the average case, but which occasionally continues for several weeks, the cough tends to become paroxysmal, is much worse at night, and is apt to be followed by vomiting.

The Paroxysmal Stage.—This, the stage of the “whoop,” is characterized by the occurrence at varying intervals of paroxysms of coughing of a peculiar type. These accesses may appear as often as every hour or half-hour in very severe cases, but seldom exceed sixteen or eighteen in the twenty-four hours, and are usually much less frequent. The *paroxysm* consists of a large number of short explosive coughs, as if the patient were trying to expel something lodged in his larynx. The coughs succeed one another too rapidly to give any time for an inspiration, but ultimately there is a violent inspiratory effort, and the air inspired through tense vocal cords causes the prolonged crowing sound which constitutes the typical whoop. Usually the process is repeated several times, the patient becoming more and more distressed, until the

congested face may be almost purple and tears stream from the injected and starting eyes. Mucus and sticky expectoration trickle from the nostrils and mouth, and in violent attacks are often tinged with blood. The tongue is protruded in the effort of the cough, and the sphincters not uncommonly relax. The paroxysm is very frequently concluded by vomiting. The child always sits up to cough, and sinks back exhausted when the access is over. It obviously suffers intensely, and its efforts to stave off a paroxysm, which it feels coming on, are often very pitiable to witness.

In very severe cases the paroxysm may end in a convulsion, and in exceptional circumstances death may occur from syncope. Usually, however, relaxation of the glottis occurs in time to prevent a fatal result.

Many children have a premonition of the impending paroxysm for several minutes before it actually occurs. Some appear to feel a sensation of constriction of the chest. Others may yawn or sneeze. Many commence crying, and this usually precipitates the occurrence of the cough. Giving food or drink shortly before a paroxysm is due will often bring it on. On the other hand, fear and other mental emotions occasionally inhibit the cough.

The paroxysms are most numerous and most severe at night, waking the patient at intervals. Usually sleep is obtained between the spasms. The general health of the patient is in most cases affected, and children are apt to be dull and apathetic. If the cough is severe and frequent, the face becomes slightly puffy, the eyelids are œdematous, and the lips show a tinge of cyanosis. Much vomiting is apt to be attended by wasting, and weakly children sometimes die of marasmus. There is no fever in this stage unless complications are present.

The paroxysmal stage usually lasts about six weeks,

towards the end of which time the accesses of coughing become less numerous and severe. Some children, however, will continue to whoop for months, and in others the peculiar type of cough seems to be acquired as a habit, and the illness may appear to recur when there is any slight catarrh at a subsequent date.

Convalescence.—When once the cough commences to improve, the patient regains his health and spirits rapidly.

Complications and Sequelæ.—We have already seen that the strain of coughing tends to cause œdema of the face. Occasionally *hæmorrhages* occur. Epistaxis is common, and the blood seen in the sputum is doubtless due to the rupture of small vessels in the congested respiratory passages. Subconjunctival hæmorrhage is seen in two or three per cent. of all cases, the whole white of the eye being sometimes masked by a thin layer of bright red blood. Bleeding may also occur into the eyelids, and the resulting black eye may be supposed to be due to injury. Hæmorrhage from the ear may also, though very rarely, occur during the paroxysms.

Another condition mechanically caused by the violence of the cough is *ulcer of the frænum of the tongue*, which is seen in young children who have cut their two lower incisors. The tongue protruded in the act of coughing is pressed against the edges of these teeth, and a greyish oval patch of ulceration is formed on the under surface of the frænum. The ulcer does not appear till the paroxysmal stage is well developed, and heals rapidly when convalescence is established.

Digestive troubles are common, and diarrhœa may be troublesome. The violence of the cough is liable to cause prolapse of the rectum and hernia.

Respiratory complications are the most important. Some degree of bronchitis is to be expected in the

majority of cases, but it is usually limited to the larger tubes and does not affect the temperature. Laryngitis, as has been noted above, may complicate the catarrhal stage and may be severe enough to cause obstruction. Broncho-pneumonia is responsible for the high death-rate so often observed in whooping-cough. The condition resembles that met with in measles. It is usually characterized by fever, a rapid pulse, and very frequent respirations. The face is pale with a slightly cyanotic tinge, and the alæ nasi move on respiration. Areas of dulness may be detected in the lungs, and fine crepitations are heard on auscultation. In infants a severe paroxysm sometimes causes collapse of a comparatively large area of lung tissue, and this may be followed by syncope, convulsions, or sudden death. Some degree of compensatory emphysema is commonly met with in pulmonary complications, and is found in the upper part of the lungs. In the presence of complications, which are most common in the second or third week of the paroxysmal stage, the paroxysms become much less frequent, and a sudden reduction in the number of whoops may point not to improvement but to the development of some intercurrent condition.

Nervous complications are liable to supervene, as is only to be expected in a disease in which nervous irritability is such a marked feature. *Convulsions* occur not uncommonly and are very often fatal. They may appear as a result of a paroxysm, or quite independently in the interval between the accesses of coughing. They may be either tonic or clonic in character, and may be general or localized. They may occur singly or be repeated at short intervals till death. They are probably due in most instances to toxæmia, but have been attributed to meningeal hæmorrhage and to thrombosis of the sinuses. Severe forms of nervous disease, such as hemiplegia, ascending paralysis,

and neuritis, have been described as complicating or following an attack of whooping-cough.

The *sequelæ* of whooping-cough are also important. Cardiac dilatation is the occasional result of the strain of coughing, and valvular disease has been reported. The chest may remain permanently deformed, and chronic bronchitis, emphysema, and asthma may persist as legacies of the disease. Tuberculosis is very liable to follow a prolonged broncho-pneumonia, and the bronchial glands may be left permanently enlarged.

The Blood in Whooping-Cough.—A high leucocyte count is a feature of the disease from its onset. An average count in the catarrhal stage is about 20,000 white cells. The lymphocytes are always absolutely or relatively increased in numbers, the average lymphocyte percentage being as high as 66 in the catarrhal and paroxysmal stages. When complications are present the leucocyte count may be very high, for instance 185,000 in a case with broncho-pneumonia. The blood therefore presents features characteristic enough to be of value in diagnosis.

Second Attacks.—These are extremely rare. The protection afforded by whooping-cough appears to be greater than that conferred by the majority of infectious diseases.

Diagnosis.—In the catarrhal stage this is always extremely difficult unless there is a definite history of exposure. When the cough, however, becomes more paroxysmal in character and is distinctly worse at night, there is reason for suspicion. The first actual whoop nearly always occurs at night. Vomiting after an access of coughing is another suspicious feature. The gradual exacerbation of the cough in spite of appropriate treatment should also distinguish this stage of the disease from an ordinary catarrh. In hospitals, blood examination often gives useful information and

assists in the early isolation of the suspected child. Diagnosis becomes easy once the whoops have developed. If the medical attendant does not see the child in a typical paroxysm, he can endeavour to excite one by examining the throat, and he can also examine the under surface of the tongue for typical ulceration. Puffiness of the face or œdema of the eyelids, taken together with a history of paroxysmal attacks of coughing, which are worst at night, should go far to make a definite diagnosis.

In the early days of the catarrhal stage the disease may have to be distinguished from the similar stage of measles. The absence of Koplik's spots should be sufficient to exclude it. Tubercular disease of the bronchial glands is said to cause accesses of coughing which closely resemble whooping-cough, and we may have to be guided by the history of exposure on the one hand or by the presence of tubercular glands in the neck or axilla on the other.

Prognosis.—This should always be guarded in patients of under three years of age. The hospital mortality is very high, especially in the case of young infants, who in some epidemics show a case death-rate of 35 per cent. But it is obvious that hospitals deal with enfeebled and neglected children, and in good class practice the illness is much less fatal. The mortality becomes less as age advances, and if we except the cases which occur in the aged, is trifling after ten years of age. It is said that females have a worse chance of recovery than males, but hospital statistics hardly support this contention. Prognosis depends largely upon the condition of the patient at the time of the attack. Rickety and tubercular children have a high mortality.

The longer the catarrhal stage lasts the milder is the paroxysmal stage likely to be. During the latter

the gravity of the illness may be fairly estimated by the number and severity of the spasms. As long, however, as the patient remains well and bright in the intervals between the paroxysms and does not show marked wasting, we are justified in taking a hopeful view.

The chief causes of death are the complications. The mortality of broncho-pneumonia cannot be expected to be much less than 40 per cent. of those attacked. Over 70 per cent. of the cases in which convulsions occur terminate fatally.

Treatment.—In the catarrhal stage, if it is recognized, it is wise to keep the patient in bed. When the whoops have developed, provided there is no pyrexia, he can be allowed up. The child should be warmly clad, but not so loaded with clothes as to encourage sweating. Many medical men recommend that a steadily maintained even temperature, 65° or over, is desirable in the treatment of whooping-cough, but there are many advantages to be gained from free ventilation, and patients can be allowed out of doors safely unless the weather is excessively damp. Children who may be reasonably supposed to suffer from any predisposition to chest disease are best kept in bed, and can be carried if necessary into the open air. They should have the chest rubbed night and morning with some stimulating oil, and protected with a light jacket of Gamgee tissue. All children should be sponged or bathed frequently. Nurses should always endeavour to support the patient during a paroxysm, and should be prepared with a spittoon to receive coughed-up or vomited matter. The bowels should be carefully attended to and constipation avoided.

Diet.—For severe or feverish cases a fluid diet is best, and should consist of milk, supplemented if necessary by albumin water or meat juice. The average

patient, however, will tolerate an ordinary diet, care being taken to avoid substances likely to cause much acidity, such as starchy puddings, jam, or fruit. Even when much is lost by vomiting, there is no reason for alarm unless the patient is obviously wasting. Should that be the case, very light and digestible food should be given, and care taken to feed just after a paroxysm, so that time is allowed for digestion before vomiting occurs in the next access of coughing. In certain cases it may be wise to peptonize the milk, and some children will take whey if it is found that milk is badly digested. One of the advantages of allowing patients into the open air is that the appetite is encouraged, and in a prolonged case this is a matter of considerable importance. Some children, who suffer from extremely severe spasms, will occasionally refuse food altogether. If their appetite cannot be tempted by allowing them any kind of food they may fancy, a course quite justifiable in the circumstances, rectal feeding may have to be resorted to.

Stimulation is seldom necessary except in complicated cases. Occasionally, however, there is great exhaustion after the whoops, and a little white wine whey or a few drops of whisky may be administered with advantage.

Drugs.—The extraordinary number of drugs which have been recommended as useful in whooping-cough is quite sufficient proof that drug treatment is as a rule disappointing. There is no remedy which can be depended upon to cut short the disease, or even to modify with any certainty the severity of the paroxysms. The drugs employed may be classed as tonic, expectorant, and antispasmodic. Thus quinine has a considerable reputation, and is certainly useful for its tonic effects towards the end of the paroxysmal stage. A few drops of ipecacuanha wine given at regular inter-

vals possibly makes the cough slightly easier, and assists the patient to get up the stringy and tenacious mucus which is apt to be expectorated during the paroxysms. Antispasmodic drugs may be reserved for bad cases. Perhaps the most efficacious is antipyrin, but this can hardly be given with safety to young and enfeebled children, and its use is therefore limited. Belladonna is well tolerated, but if it is to have any effect at all it must be pushed till the pupils are widely dilated. Starting with 2 or 3 minims of the tincture every four hours, the dose can be gradually raised by the addition of one minim daily. With belladonna small doses of ammonium or sodium bromide may be combined. Recently Benzyl-Benzoate, 5 to 40 drops of a 20 per cent. alcoholic solution, has been recommended. The intramuscular injection of ether, 2 c.c. every alternate day for three doses, is said to influence the paroxysms very favourably. A smaller amount is suggested for infants of under six months. When one drug is found to be of no effect it is wise to try another, but it is well to expect many disappointments. Indeed, Professor Osler's suggestion of "Six weeks and a big bottle of paregoric" is as practical as any other for the treatment of whooping-cough.

A firm *bandage* round the abdomen and lower ribs gives much support to children who suffer from severe paroxysms. It should, if possible, be made of elastic material, and prevented from slipping by braces applied over the shoulders.

As to the *treatment of complications*, patients who suffer from broncho-pneumonia usually require free stimulation. When cyanosis is very marked the application of leeches is sometimes of benefit. So far as can be managed, the cases should be treated under open-air conditions. Appetite is encouraged and sleep is secured by this method, and the risk of subsequent

tuberculosis is much diminished. Convulsions are so often fatal that much cannot be expected from treatment. A hot bath with mustard may be given during the fit, and chloral and bromide administered by the rectum at regular intervals. If diarrhoea is troublesome, a dose or two of grey powder and the washing out of the large intestine with hot water are often effective.

Treatment in Convalescence.—Iron tonics, quinine, cod-liver oil, and malt foods are all useful. A complete change of air, if possible, is to be recommended.

Specific Therapy.—Although experiments with serums have been made, as yet there is no preparation obtainable by the profession. *Vaccines*, on the other hand, are used extensively, particularly in America. Large doses are required, rising from 1000 to 5000 millions of the Bordet-Gengou bacillus, the injections being made on alternate days and on four or five occasions. Some authorities prefer mixed vaccines, adding varying quantities of staphylococci, streptococci, influenza bacilli, and pneumococci. Vaccines of this type are now readily obtainable. Conflicting accounts regarding their value are given by different observers.

Isolation.—It is customary to keep a patient isolated for six weeks after the commencement of the paroxysms, provided they have not entirely ceased by an earlier date. The infectivity during the paroxysmal stage is nevertheless very trivial. An exposed child may be quarantined for fifteen days.

Prophylaxis.—During an epidemic it might be wise, especially in schools, to isolate all children who suffer from febrile catarrh, or whose cough shows any tendency to be paroxysmal or worse at night. In hospitals blood examinations give assistance in detecting early cases, but the disease is difficult to control. The disinfection of suspected sputum is a wise precaution.

The evidence in favour of the prophylactic use of

vaccines is steadily increasing. Three doses of 5000 millions of the Bordet-Gengou bacillus should be given on alternate days. These doses are well tolerated even by small infants, and there is little or no reaction in the majority of cases. A few babies may show local redness and swelling.

CHAPTER XIV

MUMPS.

Etiology.	Complications.
Infection and Dissemination.	Diagnosis.
Period of Incubation.	Prognosis.
Stage of Invasion.	Treatment.
Course of Illness.	Isolation and Quarantine.
Localizations other than the Parotid.	Prophylaxis.
The Blood in Mumps.	

Synonyms—Specific Parotitis ; Epidemic Parotitis.

Etiology.—The micro-organism responsible for mumps has not yet been discovered. It appears to be a filter passer, and has been proved to exist in the saliva of persons suffering from the disease. It is, presumably, ultra-microscopic.

Season or climate appear to have little influence on the production of epidemics. The majority of persons attacked are between the ages of five and fifteen years. Infants very rarely suffer, and the disease is uncommon in persons of over forty.

Infection and Dissemination.—The infection is derived from the secretions in the buccal and nasal cavities of persons suffering from the disease, and is usually communicated by droplet infection. It is short-lived, but can apparently be carried some distance on the clothes of a third person.

Incubation.—The period is somewhat long, and varies from twelve to twenty-six days. In most

patients the latent stage is from seventeen to twenty-one days.

Invasion.—It is only occasionally that a definite prodromal stage is noticed. If it occurs, chilliness, malaise, headache, and fever are the usual symptoms, and a fair number of patients complain of sore throat. Earache may also precede the swelling of the parotid, and epistaxis is sometimes an early symptom.

Course of Illness.—The most marked feature of mumps is parotitis, which for the first day or two is unilateral. The swelling is usually first visible in the hollow below the ear, and is as a rule sufficiently obvious. It spreads forwards and downwards, and often assumes considerable dimensions. The other parotid gland rarely escapes, becoming affected in most cases within three days of the onset. The sub-maxillary and sublingual glands are often but not always implicated, and in some patients the cervical glands are also enlarged. In well-marked cases the swelling advances from both sides until it meets under the chin, and occasionally it may spread so far downwards as to reach the clavicle. The appearance of the patient is somewhat ridiculous in consequence. There may be much œdema of the face and eyelids. The skin over the affected parts is tense but not reddened. There is much tenderness to touch, but little pain except on moving the jaws as in mastication. There may be much difficulty in opening the mouth.

The throat is probably always congested, but it is difficult to obtain a satisfactory view of it. Sometimes the mucous membrane in the neighbourhood of the orifice of Stenson's duct is especially reddened. In some patients the mouth is dry; others suffer from an excessive secretion of saliva.

The enlargement of the glands appears to depend chiefly upon the swelling of the connective tissue

surrounding it. It is said that neither the parenchyma nor the interstitial tissue is inflamed.

The resolution of the swelling takes place in most instances very rapidly, the gland regaining its normal size in a week or ten days from the commencement of the process. Relapses, however, sometimes occur. Resolution is more rapid in children than in adults, who on the whole suffer more severely during the illness. Suppuration is extremely rare. When it occurs it must be attributed to a secondary infection by pyogenic organisms.

Mumps may or may not be attended by fever. Some patients go through the whole illness without it, and it is probably more usual and better marked in adults than in children. It is irregular in character, presenting no characteristic curve.

Localizations other than the Parotid.—In certain cases the gland primarily affected is the *submaxillary*, and the swelling may be limited to this situation. As a rule, however, the parotid is secondarily involved.

Mumps is also liable to affect the sexual glands. *Orchitis* is relatively common, occurring in about one-fifth of males above the age of puberty. It usually appears about a week after the onset, that is when the parotid swelling is commencing to subside. This apparent shifting of the disease from one gland to another has been regarded as an instance of *metastasis*, but it probably only points to the affection of another organ by the virus of the disease. Orchitis, though usually secondary, may be the only manifestation of mumps.

When the testicle is attacked the constitutional symptoms are severe. The temperature runs up to high levels, and shivering, vomiting, and delirium are often observed. Sometimes the patient is collapsed. The testicle rapidly increases in size, and is usually

very tender to touch. It is not always, however, painful, and some patients may become very ill without even giving a hint that they are suffering from any local condition. The epididymis is often unaffected, but a slight urethral discharge is sometimes present. It is seldom that the inflammation lasts for more than a few days, and the swelling subsides as rapidly as it appeared. The other testicle may become involved. The serious feature of orchitis is that the parenchyma of the gland may be affected by the inflammation and atrophy may result.

In females ovaritis and mastitis are sometimes observed, but are not nearly so common as the orchitis of the opposite sex.

Pancreatitis appears to be comparatively common in some outbreaks, and its onset is attended by alarming symptoms of collapse. There may be vomiting and marked epigastric pain. Sometimes a tender transverse swelling can be palpated. The gland is affected, like the testicle, about the time at which the parotid swelling subsides.

The Blood in Mumps.—There is not much increase in the number of the leucocytes, but a very definite *lymphocytosis* almost invariably occurs and with very few exceptions is present from the first. Occasionally, however, it is not evident before the third day of illness. It is said to persist for about a fortnight. This peculiarity is of real value in distinguishing a specific from a septic parotitis, and is said also to determine whether orchitis is due to mumps or to gonorrhœal infection.

Complications.—These are, generally speaking, rare, and need only be mentioned. Arthritis sometimes occurs. Various forms of erythema have been described. Of more importance are the meningeal symptoms which occasionally precede the parotid

enlargement. A meningeal reaction is present in most cases, a definite increase of lymphocytes in the cerebrospinal fluid having been noticed by many observers. True meningitis is probably only seldom present, but is said to occur in rare instances in convalescence. In some patients mental disturbance appears to follow the attack. *Deafness* is an occasional complication of mumps. It may be due to the results of otitis media caused by infection through the Eustachian tube, or what is more serious, to damage done to the labyrinth by the actual virus of the disease.

Diagnosis.—This is easy during an epidemic. Slight swellings of the parotid are usually best detected if the patient is placed so that the outline of the face and neck can be seen on both sides at once. At first there may be nothing more obvious than a slight fullness under one ear. The tendency of the condition to become bilateral should clear up a doubtful case, the parotitis which occurs in the course of acute infections being usually limited to one side. Difficulty in opening the mouth without pain is always suggestive, but this sign is not infrequently lacking in mild cases. It is well to remember that in diphtheria with great glandular enlargement, a condition which has on occasion been regarded as mumps, the mouth can be opened quite easily. The occurrence of suppuration in an enlarged parotid gland is very much against a diagnosis of mumps.

The disease has to be distinguished from the septic parotitis of the acute infectious diseases such as typhus and enteric fever, from the enlarged glands which complicate scarlatina and diphtheria, and from the parotid swellings met with in iodism and lead poisoning.

Unless parotid swelling is also present, or there is a definite history of exposure to mumps, the diagnosis

of the disease when it affects the submaxillary glands is almost impossible. The same may be said of orchitis occurring as the sole manifestation of mumps, but if the disease is prevalent and venereal infection is unlikely, it may be reasonably attributed to that cause. A differential blood count is of great assistance.

Prognosis.—Such untoward accidents as the appearance of meningitis in convalescence are so seldom met with, that it may be said that the prognosis of mumps is extremely good. There is, however, always a risk of subsequent deafness, and the possibility of the atrophy of one or both testicles should also be recollected. Children, as a general rule, seem to suffer less and to recover more quickly than adults.

Treatment.—While there is any fever the patient must be kept in bed, and it is wise to continue this restriction until the risk of orchitis is past, say for ten days. The food should consist of fluids or soft solids. Attention should be paid to the toilet of the mouth, which it is advisable to clean out at regular intervals with antiseptics. For the local condition hot fomentations frequently renewed are as useful as anything else. In mild cases it is sufficient to cover up the swelling with cotton wool and a bandage. Belladonna ointment applied on lint appears to give much relief to some patients. When *orchitis* supervenes the parts must be adequately supported, and it is wise to keep the bowels freely open. Local treatment similar to that advised for the parotid may be employed. For cases of *deafness*, due to inflammation in the internal ear, the hypodermic injection of pilocarpine has been recommended and should be tried from the first. Lumbar puncture has also been suggested with a view to relieving sub-arachnoid tension. The condition, however, is not a hopeful one.

Isolation.—This should continue for three weeks from the first symptom of illness, and if the case is much prolonged, for at least a week after the entire subsidence of the parotid swelling. *Quarantine* must be long, and should not be less than twenty-six days.

Prophylaxis.—The prompt isolation of patients coupled with the rigid quarantine of susceptible contacts is all that can be done to cut short an outbreak.

CHAPTER XV.

CEREBRO-SPINAL MENINGITIS.

Etiology.	Relapses.
Infection and Dissemination.	Types.
Pathology.	Diagnosis.
Period of Incubation.	Prognosis.
Stage of Invasion.	Treatment.
Course of the Illness.	Isolation.
Complications.	Prophylaxis.

Synonyms—Cerebro-spinal Fever ; Spotted Fever ;
Post-basic Meningitis.

Etiology.—Cerebro-spinal meningitis may occur either in small localized outbreaks or in widespread epidemics, and the cases of “post-basic meningitis” not infrequently observed in our children’s hospitals may be regarded as sporadic instances of it. Climate exercises but little influence, for it occurs both in tropical and temperate regions. In the latter its typical season is early spring, most cases occurring in March and April, probably because, owing to the prevalence of influenzal colds and catarrhal conditions, the virus is more readily distributed by carriers in the early months of the year. Males are affected in greater numbers than females. As regards *age*, infants and young children appear to take the disease most readily, and susceptibility decreases with advancing years. Predisposing factors are fatigue, change in conditions of life, want of ventilation, and particularly *overcrowding*. It is not sur-

prising, then, that the disease should be comparatively frequently observed in barracks, and especially among new recruits.

Bacteriology.—The causative micro-organism is the *Diplococcus intracellularis* of Weichselbaum. It is found in the cerebro-spinal fluid and meninges of persons suffering from the disease, and has been isolated from the blood and the secretions of the nose and eyes. It also has been found in the throat secretions of "contacts." In appearance it resembles the gonococcus, occurring in pairs and sometimes in tetrads. There is no capsule. It is often found in the cells of the spinal exudation, but in some instances may be entirely extracellular. It is negative when examined by Gram's method, and grows best on a medium of agar and ascitic fluid, or on tryptagar.

Four types of meningococci have been isolated. The only method of distinguishing them is by means of the agglutination reaction. They are classed Types I, II, III, and IV respectively, the first two being most commonly met with, the others, especially the last, occurring much less frequently. Of these types, I and III, and II and IV appear to be closely related, the first pair conforming to the group described by French writers as the meningococcus, whereas the second pair corresponds with the *para-meningococcus* of Dopter. These groups and types are of considerable importance, as the success of specific treatment depends on the infecting micro-organisms being combated with the appropriate serum.

Infection and Dissemination.—Infection rarely takes place directly from person to person, and the dissemination of the diplococcus is believed to take place through the medium of an intermediary or healthy "carrier." Adults exposed to infection appear to harbour the micro-organism very frequently in

their faucial and nasal secretions, and by coughing, sneezing, or spitting are liable to distribute it. Only a small proportion of the population appears susceptible to the disease itself, and when an epidemic occurs it is in reality much more an epidemic of carriers than of cases. It is possible also that fomites, such as handkerchiefs, spoons, cups, and so forth, which have become contaminated by these carriers, may infect susceptible persons, but the meningococcus is such a delicate micro-organism, and so short-lived, when exposed to even moderate degrees of cold, that infection of this nature is probably uncommon. On the other hand, it is remarkable how often children sleeping in the same bed with a person suffering from the illness escape.

Pathology.—The diplococcus is believed to first obtain lodgement in the throat or nose. What is the path of infection from that situation has been the subject of much discussion. The view that the meninges are reached by way of the olfactory filaments through the cribriform plate, or that infection occurs through the sphenoidal sinuses, is not now so widely held as formerly. It is possible that the meningococcus travels by the lymphatics to the cord, but more probably it is carried by the blood stream to the choroid plexuses of the lateral ventricles. In any case the disease not infrequently starts as a septicæmia, and may continue as such without infecting the meninges at all.

Morbid Anatomy.—The typical lesions consist of an acute inflammation of the pia arachnoid with effusion, sometimes merely turbid, often quite purulent, into the subarachnoid space. In early cases the upper part of the brain may present congestion only, but usually there is a suggestion of milkiness beneath the arachnoid along the lines of the sulci. Occasionally

thick purulent matter plasters the vertex. In most cases, however, the more severe lesions are concentrated at the base, the under surface of the cerebellum and pons suffering most. The exudate is gelatinous or purulent in consistence, and usually yellow in colour, occasionally with a greenish tint. It seldom extends forwards beyond the optic chiasma. When the membranes of the cord are laid open, turbid or purulent fluid escapes. The inflammatory changes vary from hyperæmia to a thick plastering of both surfaces with purulent lymph. Even after only three or four days' illness, the cord may be found thickly coated with sticky pus. Empyema of the sphenoidal sinuses is very frequently present.

Incubation Period.—This is probably short, but it is impossible to state with any degree of certainty its exact duration. The curious mode of transmission by means of an intermediary renders its determination very difficult. We may assume from such facts as have been reported that it is from one to five days, and is usually under four.

Invasion Stage.—The onset is very sudden and abrupt. Sometimes the patient becomes rapidly unconscious. Otherwise he is almost certain to complain of headache, stiffness in the neck, and feelings of chilliness. He usually vomits, and often has a definite rigor. In children convulsions are sometimes noted. Some degree of fever is invariable at the outset.

Course of the Illness—There is a definite acute stage which is often ended by the death of the patient. Should death not supervene in the first fortnight, recovery may occur, or the condition may become chronic for many weeks, ultimately terminating either by death or convalescence.

The Acute Stage.—This may last from a few hours

to about three weeks, though, if death supervenes, in the great majority of cases it is not before the third day, and, on the other hand, marked improvement and the convalescent stage cannot be expected before the end of the first week. The patient is flushed, and the complexion may show a slight cyanotic tinge. The mind is confused, and there is often more or less delirium. Adults complain much of headache and of pain in the back of the neck. The head is held rigidly retracted, and it will be found difficult to bend it forward on the chest. Strabismus is occasionally present. The pupils may be unequal, but are usually equal and react sluggishly to light. The temperature is in most cases elevated, the pulse varying considerably in rate and character. The tongue is furred and dry. In male adults retention of urine is not uncommon. In the more severe cases petechial spots and moderate-sized purpuric blotches may appear upon the skin within twenty-four hours of the onset; but this feature of the disease, to which the name "spotted fever" is due, is not to be expected in more than 20 per cent. of patients. Herpes, especially of the lips but also occurring in almost any situation, is much more common. In some cases total deafness or blindness is present from the first.

Kernig's sign is nearly always present, that is to say with the thigh semiflexed on the abdomen it is impossible to extend the leg. The knee-jerks are often normal, but sometimes abolished. The abdominal reflex is very frequently absent. The patient is hyperæsthetic, and resents touching or handling, and appears particularly sensitive to cold. Lying on his side with the head slightly or markedly retracted, he often moans or screams, the pain in the head and back being almost constantly complained of if he is

not asleep. Occasionally there is wild delirium, but usually the patient does not attempt to leave his bed. In fatal cases the respiration becomes laboured and irregular, though not always rapid, the face is much cyanosed, and purulent discharge pours from the nostrils. The skin becomes dusky and often mottled, and death supervenes, sometimes with hyperpyrexia, occasionally by a relatively sudden collapse. A very large proportion of the total deaths occur in the first week of the illness. In milder cases the symptoms during the first week remain much the same, though there is some variation in their intensity in the same patient at different times. One day the mind may be clear and headache scarcely complained of; the next the patient may be delirious and literally roaring with pain. This alternation in the severity of the symptoms is often a striking feature of the disease and compels us to be very careful as regards prognosis.

In a certain proportion of patients, especially in those treated with a reliable serum, a marked improvement may occur about the end of the first week. The temperature falls first. The rigidity of the neck and

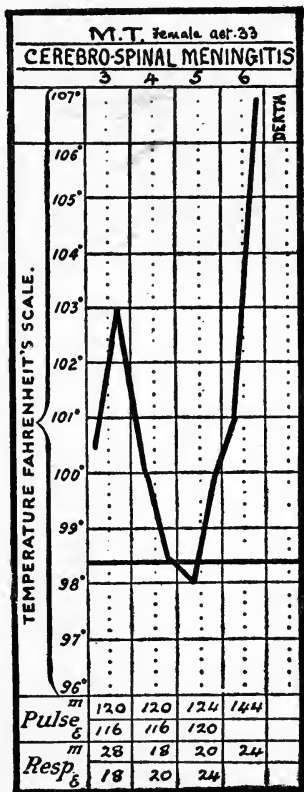


FIG. 14. Cerebro-spinal Meningitis. Showing irregular course of the temperature.

headache persist for a few days, but gradually subside, and it is not unusual for Kernig's sign to persist for ten days or a fortnight after all other symptoms have disappeared. The earlier the improvement occurs the less the chance of the case becoming chronic, but some patients make an excellent recovery even after three weeks of severe illness.

The Chronic Stage, very commonly seen before the introduction of serum treatment and systematic lumbar puncture, is of comparatively rare occurrence in judiciously treated patients. It depends on the presence of *hydrocephalus*, which may be due to want of sufficient drainage or to the definite encysting of fluid in the ventricles as the result of adhesions. The most marked feature is perhaps progressive *wasting*. This will be noted quite independently of the amount of food taken by the patients, many of whom eat voraciously all through a severe acute stage. The loss of flesh is truly remarkable, and is quite as well marked in patients with normal as with subacute temperatures. The main features of the illness, neck rigidity with head retraction and persistence of Kernig's sign, are always present. In young children *opisthotonos* is very common, and may be extreme. Rigidity of the limbs is also often noticed, and the arms are apt to be extended with the forearm pronated and the thumb turned into the palm. Vomiting, apparently causeless, is very common and recurs at frequent intervals. Convulsions not infrequently occur, and may terminate the case. Such symptoms as ptosis, nystagmus, strabismus, and conjugate deviation are all liable to appear. In the later stages there may be exophthalmos, mental feebleness, muscular rigidity, paralysis of the cranial nerves, and often profound unconsciousness. In infants protrusion of the fon-

tanelles and separation of the cranial bones are to be expected.

Involuntary passage of urine and fæces is common. The extreme emaciation of the patient renders him very liable to bedsores. Death is often long delayed, sometimes for three or four months. On the other hand, a patient may remain in the chronic stage for several weeks and ultimately recover, the last symptom to disappear being Kernig's sign.

Complications.—These are, on the whole, few and unimportant, except for those which affect the ear and eye. Cerebro-spinal meningitis is a frequent cause of deaf-mutism. The deafness may be absolute and permanent by as early as the second day of illness, and is due to damage to the nerves. Otitis media not infrequently occurs in the chronic stage and may leave partial deafness behind it. The conjunctiva is often inflamed, and for this the meningococcus itself seems sometimes responsible. Iridochoroiditis is occasionally observed early in the illness, and ulcer of the cornea, sometimes followed by panophthalmitis, may occur in the chronic stage. Blindness, either temporary or permanent, may appear at all stages. It depends, like deafness, on central rather than local lesions.

Relapses.—Repetitions of the original fever, after an interval of complete apyrexia and freedom from any acute symptoms, have been not very uncommon in some outbreaks, but are distinctly rare in others. Relapses may be repeated several times in the same patient and are liable to terminate fatally. They present the same clinical features as the original attack, and the spinal fluid becomes once more turbid, and contains meningococci. They must be distinguished from *recrudescences* or exacerbations of the fever before the spinal fluid is free of germs,

and also from the febrile symptoms due to hydrocephalus.

Types.—As in the other acute fevers, there is a “fulminant” type characterized by very severe symptoms, such as profound coma and well-marked purpura from the first. Death may occur within a few hours of the onset, and is seldom delayed for more than two days. There are also mild varieties of the illness, which have been described as “ambulant” and “abortive” respectively, and which are not likely to be recognized except in the presence of an epidemic. In small infants the disease may run the course of what used to be described as *post-basis meningitis*, and is now defined as chronic encysted meningococcic meningitis. The illness often starts insidiously, but the type may be assumed by infants who have presented the sudden onset and classical symptoms of the usual epidemic form. Sporadic cases of this variety of meningitis are not uncommon. The course of the illness is chronic, and great distortion and opisthotonos are often observed.

In some patients the meningococcus does not attack the meninges, but remains in the blood stream. Such a *meningococcaemia* is usually rapidly fatal, and is often accompanied by purpuric hæmorrhages. Mild and prolonged cases, however, have been reported, and owing to the difficulty of diagnosis may be more common than has been suspected.

Diagnosis.—During an epidemic diagnosis is not very difficult. Sudden onset of illness, with headache, vomiting, neck rigidity, and Kernig’s sign, are sufficient to justify the lumbar puncture on which the final identification of the disease must depend. The significance of purpuric spots or of herpes should be remembered. With the possibility of serum treatment in view early diagnosis is highly important.

The conditions most difficult to distinguish from cerebro-spinal fever are other varieties of meningitis. Of these tubercular meningitis is the most frequently met with. Its onset, however, is much more insidious than that of cerebro-spinal meningitis, and its symptoms less acute. The spinal fluid, moreover, is clear, and the cells which are found in it are of the lymphocyte variety. The retracted abdomen so often observed in a tubercular case is seldom seen in the epidemic fever, and then only if emaciation is extreme. Pneumococcal and septic meningitis may very closely resemble the meningococcal disease, and the distinction must depend upon bacteriological tests. As apart from these forms of meningitis, the fever must be differentiated from meningism due to toxæmia occurring in the course of enteric fever, lobar pneumonia, or any other acute infection. In cases of this sort it is unusual to find Kernig's sign positive. Some patients suffering from lethargic encephalitis present great rigidity of the neck and occasionally Kernig's sign, and lumbar puncture is necessary to make a diagnosis, a clear fluid being obtained.

Bacteriological Diagnosis.—To obtain spinal fluid for examination, lumbar puncture is necessary. The patient should lie on the side with the knees well drawn up and the head and shoulders as far forward as possible. The spines of the vertebræ having been made prominent, the needle should be thrust into the space between the fourth and fifth lumbar vertebræ, which is on the level of a line between the summits of the iliac crests. The puncture is most easily made in the middle line, the needle being inserted between the spines, either absolutely straight or with a slight upward slant. Some prefer to puncture between the laminæ, in which case a point about three-eighths of an inch to the right or left of the middle line should be selected,

and the thrust made slightly inwards and upwards. Fluid is struck at a depth varying from one inch in young children to nearly three and a half in some adults. It usually exudes in drops, but may spout in a continuous stream if there is much pressure. In delirious or excitable patients a general anæsthetic may be necessary for the puncture, but, if possible should be avoided in young children. Should the fluid fail to flow, when the needle appears to be in position, it is a good plan to pass the stilette to clear any blockage, and to rotate the needle to free any membranes which may have got wrapped round the point.

The fluid is turbid during the acute stage, and in very severe cases purulent. In the chronic stage it is sometimes quite clear, but the contained cells will be polymorphs, differing, therefore, from those observed in the clear fluid of tubercular cases. A smear preparation of the fluid, if suitably stained with methylene-blue, will show in addition to the polymorph cells a varying number of diplococci, some of which are almost certain to be intracellular even in the early stage of the disease. As regards the fluid itself, glucose is usually much diminished if not entirely absent in the early stages and the amount of albumin is increased.

Prognosis.—The mortality of the disease if untreated by serum varies from 50 to 80 per cent. in different outbreaks. When a reliable serum is employed the death-rate should not exceed 40 per cent. and may be very much lower. The age of the patient is an important factor. Infants of under one year suffer very severely. After the second year of life the death-rate falls considerably, and is lowest between the ages of five and twenty. Thereafter it rises with age.

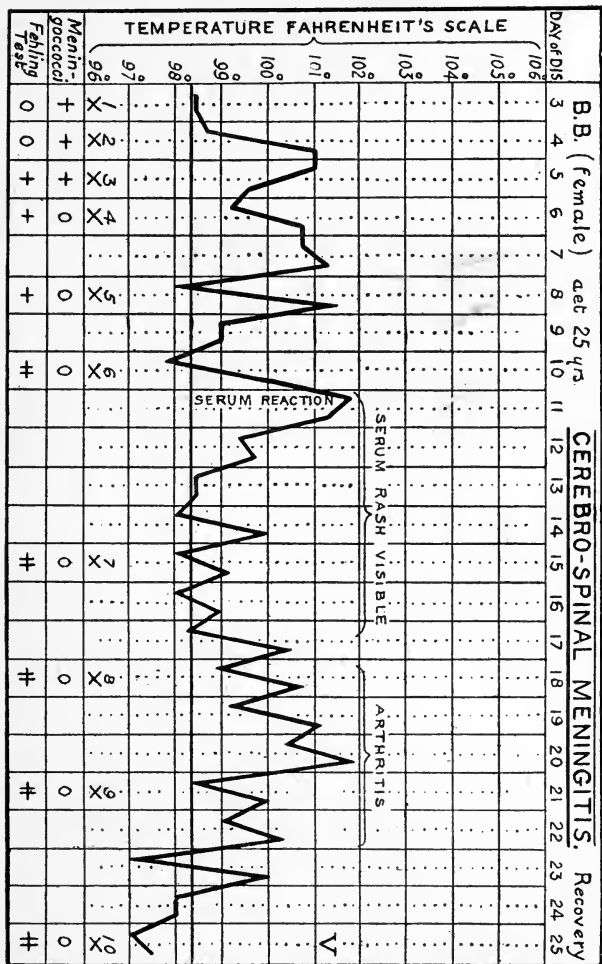


FIG. 15. Case treated with Flexner's Serum and thereafter with Lumbar Punctures. Recovery.

The numbered crosses indicate lumbar punctures, and the first six were followed by the injection of 20 c.c. doses of Flexner's serum. The remaining punctures were performed for threatened hydrocephalus, intense headache being the indication for three of them, and giddiness and vomiting for the last. Note also the serum reaction. The subsequent arthritis followed it so closely as to be in all probability due to the same cause and not meningococcal. The definite presence of sugar is indicated by +, the normal by ++. Had the fluid, which was opalescent with the onset of the reaction, been tested at the bedside, serum would not have been given.

Persistent vomiting, repeated convulsions, and the early appearance of coma are usually fatal signs. Reliance cannot be placed upon the level of the temperature, which in some instances may be quite normal only a few hours before a fatal termination. The pulse also gives but little information. Improvement in the general symptoms at the end of the first week is always hopeful, and in cases which recover one expects to find a gradual improvement in the cerebro-spinal fluid, which each day becomes clearer and shows fewer extracellular micro-organisms. An increase in the amount of glucose in the fluid is always an encouraging sign. As long as Kernig's sign remains positive, a very guarded prognosis must be given.

Treatment.—This must be directed firstly to palliating the symptoms of the patient, and secondly, if possible, to attacking the germs in the spinal canal by the injection of a bactericidal serum. As to general management, the patient should be allowed extra bed-clothes and hot bottles to counteract his sensibility to cold. The diet requires little supervision, the average patient being able to enjoy a normal diet. In cases of coma the nasal tube may be required, and the same applies to patients with extreme opisthotonos in whom there is occasionally a mechanical difficulty in swallowing. The best sedative treatment for headache or excitement is the frequent use of the hot bath. If drugs are used, sulphonal or veronal will often be found effective, and small children tolerate bromidia admirably. In very severe cases hypodermic injections of morphia are justifiable. Throughout the illness the greatest attention must be paid by the nurse to the condition of the skin, especially over the points of pressure, and the eyes may be bathed frequently with great advantage.

When a diagnostic puncture is made serum should

always be at hand and, if the fluid proves to be turbid, should be given at once without any waiting for bacteriological confirmation of the diagnosis. Even if it is intended to use "type" serum, the first dose or two must necessarily be of a polyvalent serum. Thereafter, if the type of the infecting micro-organism has been differentiated (see p. 305), the appropriate type of serum, if procurable, should be given. But very good results may be obtained by the use of the polyvalent preparation, and at present it is difficult to procure type serums either for diagnosis or treatment.

As regards *dosage*, it is a good rule to inject a smaller quantity of serum than the amount of fluid withdrawn. The relief of pressure is an important part of the treatment, and neglect of this consideration is not without risk to the patient. For infants, after abstracting at least 20 c.c. of fluid, 10 to 12 c.c. of serum, very cautiously injected, will usually be well tolerated. In children of more than 18 months a dose up to 20 c.c. may be given, and in adults about 30 c.c. is in most cases sufficient, although larger amounts may occasionally be introduced. The injection may be made very slowly with a syringe, or the serum allowed to run in by gravity from a funnel. The serum must be warmed. After each injection the foot of the bed should be raised for a few hours to encourage the distribution of the serum to the base of the brain.

In all cases the procedure should be repeated daily for four days at least, even in the face of marked improvement. Serum should also be used if a relapse occurs. It is a good rule to continue the injections as long as diplococci are distinguishable in the fluid. When the latter is clear and microscopic examination reveals only the débris of the meningococci, it is unnecessary to persist with the doses.

In favourable cases serum treatment often causes

great improvement from the first, and provided the patient is treated early, say within three days of the onset, the chances of death are not likely to exceed 20 per cent. With each day, however, that the treatment is postponed, the probabilities of recovery become less. Nevertheless, the results have been good enough to make it imperative to use serum, however late the patient comes under observation.

When the acute symptoms have subsided and the patient appears to have entered the *convalescent stage*, a careful watch must be kept for signs of hydrocephalus. Such symptoms as headache, vomiting, rises of temperature, and even sudden distaste for food should be regarded as indications for lumbar puncture.

The *intravenous injection* of serum, simultaneously with its intrathecal administration, has been highly recommended. It is particularly applicable in early cases presenting signs of meningo-coccaemia, such as purpuric hæmorrhages. Large doses, 50 c.c. or over, are required.

Vaccines obtained from the patient's own meningo-cocci have been employed, and in chronic cases are occasionally of great benefit.

Isolation.—It is well to isolate all sufferers from the disease. Detention in hospital for three or four weeks has been quite satisfactory in practice. Very few patients, however, are well enough to go out so soon. *Quarantine* if imposed need not exceed ten days, but to be safe the contacts should be proved free of meningococci.

Prophylaxis.—The disease is difficult to control. Notification and the disinfection of houses may be regarded as necessary measures. The chief methods of prevention will depend upon the supervision of contacts and, if necessary, the systematic examination of their nasal and faucial secretions for germs. Suspected

"carriers" should be instructed to gargle with chlorine water or some other suitable antiseptic, and nasal douches should also be administered. There is, unfortunately, no treatment which can be depended upon. Outbreaks in barracks can be checked by very free ventilation and by so "spacing out" the beds that the heads of the men are at least two and a half feet apart.

Prophylactic vaccination has been employed, but appears to be unnecessary.

TABLE OF INFECTIOUS DISEASES.

Disease.	Incubation.	Invasion.	Eruption.		Isolation.	Quarantine.
			Date of Appearance and Character.	Distribution.		
MEASLES . .	Usually about 10 days; extreme limits, 8-14 days.	Irregular fever, often characterized by remission; coryza, catarrh, and Koplik's spots.	Usually 4th day, occasionally a day or two earlier or later. Papules tending to become grouped.	General.	15 days from onset.	16 days.
RUBELLA . .	Usually 16-18 days; extreme limits, 12-21 days.	Slight fever; slight coryza; slight sore throat; often stiff neck.	Often first symptom noticed and seldom delayed more than 24 hours. Macules either grouped as in measles or tending to blend into a scarlatinal blush.	General, but tends to disappear rapidly from the face.	7 days from onset.	21 days.
SCARLATINA . .	Usually 2-3 days; extreme limits, 1-6 days.	Abrupt onset, with fever; headache, sore throat, and vomiting.	Usually in a few hours, seldom more than 24. Punctate spots.	General, except face, which is merely flushed and shows circumoral pallor.	5 weeks, or until all mucous or purulent discharges have ceased.	7 days.
SMALLPOX . .	Usually 10-14 days; extreme limits, 5-16 days.	Abrupt onset; high fever, with headache, backache, chills, and vomiting; often erythematous or petechial rashes.	On 3rd day. Macules rapidly becoming papules, and thereafter developing into vesicles and pustules.	General, but showing preference for face and distal parts of extremities; least marked on abdomen.	Until last crust has separated, usually in from 5-8 weeks.	15 days, unless vaccination has been performed successfully.
CHICKENPOX.	Usually 12-21 days; extreme limits, 11-24 days.	Symptoms usually not well marked; occasionally headache, fever, and malaise.	Often first symptom, and continues to appear on subsequent days. Vesicles which often become pustular.	General, but showing a preference for the trunk, especially the back; well marked on face, but scanty on extremities.	Until last crust has separated, 2-4 weeks.	21 days.

TYPHUS. . . .	Usually 10-14 days; extreme limits, 4-21 days.	Abrupt onset, with fever, headache, chilliness, and vomiting.	On 5th day. Rose spots becoming purpuric, with subcuticular mottling and petechial spots.	General, except for the face, which is completely spared.	5 weeks from onset.	15 days.
ENTERIC FEVER.	Usually 10-15 days; extreme limits, 1-21 days.	Insidious onset, with gradually increasing fever, and usually abdominal pain; often diarrhoea; sometimes epistaxis.	On 8th and subsequent days. Lenticular rose spots, disappearing on pressure, and coming out in crops.	Usually limited to abdomen, flanks, and back.	Depends more upon the strength of patient than risk of infection.	Unnecessary if contacts are kept under observation.
DIPHTHERIA. . .	Usually about 2 days; extreme limits, 1-7 days.	Often insidious, with sore throat, malaise, and moderate fever.	..	..	Until two consecutive negative cultures have been obtained from throat.	7 days, unless negative cultures are obtained from contacts.
ERYSIPELAS. . .	2-8 days.	Abrupt onset, usually with headache, shivering, and high fever.	In a few hours. Uniform blush with raised margin.	Depends on site of inoculation.	A week after all acute symptoms have subsided.	Unnecessary.
WHOOPING-COUGH.	5-14 days.	Insidious onset, with cough gradually becoming more spasmodic and worse at night.	..	..	6 weeks, or less if whooping has ceased.	15 days.
MUMPS. . . .	Usually 17-21 days; extreme limits, 12-26 days.	Often indefinite, but may be headache, earache, chilliness, or epistaxis.	..	..	3 weeks, or in prolonged cases for a week after subsidence of swelling.	26 days.
CEREBRO-SPINAL MENINGITIS	1-5 days; usually 2-4 days.	Abrupt onset, with headache, stiff neck, and high fever.	In first 3 days. Purpuric spots.	On any part of body; the eruption is only seen in a small proportion of cases; seldom profuse.	3-4 weeks.	7 days. Contacts may be examined for meningococci.

TABLE SHOWING MODES OF INFECTION

EITHER CERTAINLY, OR IN ALL PROBABILITY, ASSOCIATED WITH THE PRODUCTION OF PARTICULAR DISEASES.

CONTACT.	WATER.	MILK AND ITS PRODUCTS, <i>e.g.</i> ICE-CREAM.	OTHER FOODS AND DRINKS.
A. Actual— The venereal diseases Vaccinia Erysipelas Diphtheria Etc. etc. B. Virtual (<i>spray infection</i>)— Measles Rubella Diphtheria Scarlet fever Smallpox Chickenpox Cerebro-spinal fever Plague (pneumonic) Influenza Whooping-cough Mumps Pulmonary phthisis Pneumonia Etc. etc.	Enteric fever Cholera Dysentery	A. Direct from Animal— Tuberculosis Malta fever (<i>goats</i>) B. Contaminated by Water, Flies, or Carriers— *Enteric fever Diphtheria Scarlet fever Tuberculosis Epidemic diarrhoea	Enteric fever— (SHELL-FISH from <i>neighbourhood of sewage effluents</i> VEGETABLES, <i>e.g.</i> lettuce, celery, water-cress <i>contaminated by impure water</i> BEER)

CARRIERS.	INSECTS.	FOMITES.	AIR-BORNE DUST.
Diphtheria Cerebro-spinal fever *Enteric fever — Scarlet fever Epidemic poliomyelitis Influenza Pneumonia	<p>A. By Inoculation—</p> <p>MOSQUITOES { <i>Anopheles</i>— Malaria <i>Stegomyia</i>— Yellow fever Typhus fever Trench fever — Relapsing fever THE RAT FLEA—Plague BITING FLIES—Trypanoso- miasis, etc. etc.</p> <p>B. By Carriage of Micro-organisms and Con- tamination of Food—</p> <p>THE HOUSE-FLY . . . { *Enteric fever Epidemic diarrhoea — Smallpox</p>	<p>*Enteric fever Scarlet fever Smallpox Typhus fever (<i>textiles con- taining lice or nits</i>) Chickenpox Erysipelas</p>	<p>*Enteric fever (<i>dust of dried excreta</i>) Pulmonary phthisis (<i>dust of dried sputum</i>) — Smallpox Chickenpox</p>

* It may be presumed, as it has indeed been proved in certain instances, that the other water-borne diseases behave generally as does enteric fever.

NOTE.—This table makes no pretence of being exhaustive, but gives the more important examples of different modes of infection with a view to helping revision on the part of the student.



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